Doc.

Ontario Hydro-Electric Power Commission

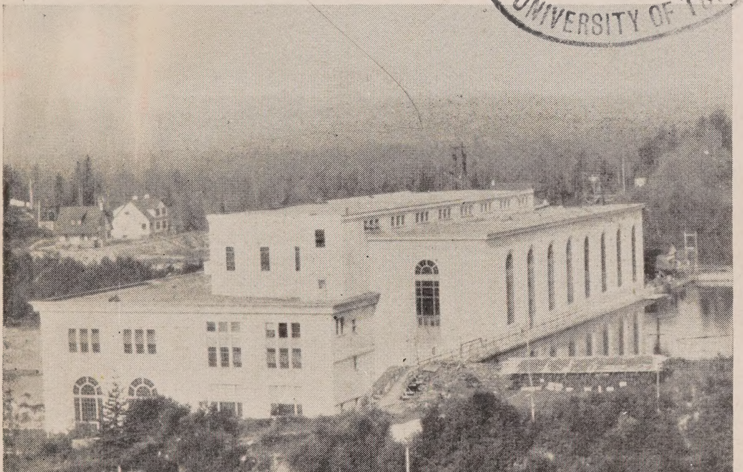
THE BULLETIN

VOL. XV NO. 1-12

Hydro news

Hydro-Electric Power Commission of Ontario

JANUARY, 1928 -1929
TO
DECEMBER



Nipigon Power House

HYDRO MUNICIPALITIES

CENTRAL ONTARIO SYSTEM

	Pop.
Belleville	13,030
Bloomfield	625
Bowmanville	3,447
Brighton	1,375
Cobourg	5,459
Colborne	987
Deseronto	1,928
Havelock	1,266
Kingston	22,368
Lakefield	1,146
Lindsay	7,840
Madoc	1,078
Marmora	853
Millbrook	733
Napanee	2,992
Newcastle	619
Newburgh	434
Norwood	711
Omemee	557
Orono	700
Oshawa	16,059
Peterboro	21,790
Picton	3,189
Port Hope	4,567
Stirling	778
Trenton	5,881
Tweed	1,268
Warkworth	500
Wellington	850
Whitby	4,131
Total	127,152

GEORGIAN BAY SYSTEM

Alliston	1,301
Arthur	1,218
Barrie	7,387
Beaverton	975
Beeton	580
Bradford	1,028
Brechin	255
Cannington	896
Chatsworth	326
Chesley	1,803
Coldwater	663
Collingwood	6,237
Cookstown	635
Creemore	603
Dundalk	690
Durham	1,622
Elmvale	600
Elmwood	350
Flesherton	417
Grand Valley	595
Gravenhurst	1,621
Hanover	2,842
Holstein	285
Horning's Mills	350
Huntsville	2,316
Kincardine	2,156
Kirkfield	138
Lucknow	918
Markdale	927
Meaford	3,000
Midland	8,085
Mount Forest	1,825
Neustadt	444
Orangeville	2,503
Owen Sound	12,360
Paisley	749
Penetang	3,896
Port McNicholl	614
Port Perry	1,142
Priceville	
Ripley	670
Shelburne	1,134
Stayner	927
Sunderland	570
Tara	597
Teeswater	807
Thornton	200
Tottenham	453
Uxbridge	1,492
Victoria Harbor	1,462
Waubaushene	600
Wingham	2,470
Woodville	448
Total	86,182

NIAGARA SYSTEM

Acton	2,000
Agincourt	350
Ailsa Craig	535
Alvinston	635
Amherstburg	2,820
Ancaster Twp	4,124
Arkona	363
Aurora	2,307
Aylmer	2,241
Ayr	796
Baden	710
Barton Twp	7,774
Beachville	503
Belle River	580
Blenheim	1,528
Blyth	692
Bolton	656
Bothwell	630
Brampton	4,406
Brantford	32,786
Brantford Twp	7,301
Brigden	400
Brussels	872
Burford	700
Burgessville	300
Caledonia	1,450
Campbellville	200
Cayuga	784
Chatham	15,525
Chippewa	1,450
Clifford	469
Clinton	1,941
Comber	800
Cottam	333
Courtright	416
Dashwood	350
Delaware	350
Dorchester	400
Drayton	
Dresden	1,393
Drumbo	375
Dublin	218
Dundas	5,054
Dunnville	3,569
Dutton	870
Elmira	2,400
Elora	1,199
Erieau	500
Erie Beach	250
Embro	463
Essex	1,753
Etobicoke Twp	15,000
Exeter	1,583
Fergus	1,815
Fonthill	500
Ford City	13,046
Forest	1,427
Galt	13,332
Georgetown	2,554
Glencoe	779
Goderich	4,287
Granton	300
Guelph	19,230

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Hydro at the Close of its Second Decade

By C. A Magrath, Chairman, H.E.P.C. of Ont.

THE end of the fiscal year just closed marks for the Hydro-Electric Power Commission of Ontario the close also of its second decade of successful service to the industries, commercial institutions and private citizens of the co-operating municipalities of the Province. In its nineteen previous Annual Reports the Commission has presented a threefold record of steady progress, embracing a remarkable expansion of power-producing facilities, a lowering of the cost of service to the consumer to a point where it is below the cost for similar service in other comparable localities, and the attainment of an assured financial position. It is a matter of gratification to be able to say that the Commission's Twentieth Annual Report, now in course of preparation, will show that the progress made during the past year has in no respect been inferior to that of previous years.

EXPANSION OF POWER SUPPLIES

Under the power contract negotiated by the Commission in 1908, whereby the first supply of electricity was obtained for the use of the co-operating municipalities of the Niagara system, the total amount reserved for future needs was 100,000 horsepower. The first supply of power was delivered by the Commission over the initial transmission networks, then being completed for the Niagara system, in September, 1910, and by the end of that year about 3,500 horsepower was being taken by eight municipalities. The Commission's seventh year saw the absorption of the last of the power provided by this contract, and the Ontario municipally owned undertaking—distributing what was then thought to be a gigantic output—was increasing its demands for power at a rate of about 30,000 horsepower annually. By the negotiation of additional con-

CONTENTS

Vol. XV No. 1

January, 1928

	Page
Hydro at the Close of its Second Decade - - - - -	1
Progress of Hydro Development in Canada - - - - -	6
Electric Srength of Solid Insulation	9
ElectricalBurnsand Electrical Shock	14
Resuscitation After Electrical Shock	18
Resuscitation Medal Presented at Sarnia - - - - - -	25
Hydro News Items - - - -	29

tracts for power, by the purchase of existing generating plants and, finally by the construction of a number of new power plants, including the largest plant of its kind in the world—the Queenston-Chippawa power development—the Commission has been able to keep abreast of the constantly increasing demands for more power. At the end of October, 1927, the power supplied by the Commission aggregated 949,700 horsepower.

During 1927, the Commission has further safeguarded the power supply for the immediate future. In addition to the contract for 260,000 horsepower—25 cycles—arranged in 1926, under which deliveries will commence before many months, the Commission has secured a further supply of 100,000 maximum horsepower—60 cycles—from the Chelsea plant of the Gatineau Power Company. Development of power from the St. Lawrence River, to which the Commission looks forward as a chief source of supply for the future, still awaits action on the part of the Federal Governments of the two countries concerned. The Commission hopes that a program may be devised whereby the people of Ontario will be permitted in the early future to make some headway in the development of the water-powers that lie in the international section of the St. Lawrence River. Meanwhile, taking account of the Gatineau power contracts and such other power as the Commission anticipates will become available from the Ottawa River and other sources, there is no reason to anticipate a power shortage in Ontario within, say, the next four or five years.

The Field for Expansion

For a number of years following the inauguration of Hydro service, rapid expansion of the demands for power took place primarily through the extension of service to areas and to consumers that had not previously been served. An intermediate period then occurred, in which the growth in the individual demands of the consumers, particularly the domestic consumers, gradually assumed predominance, and in the last five years the average residential monthly consumption of electricity has more than doubled; in the last year there was an increase of about eighteen per cent. in the amount of energy sold for domestic service.

This increase, together with the normal growth due to expanding population and to extension of industrial and commercial activities throughout the Province, has been

largely responsible for the added loads on the Commission's lines and generating plants during 1927. Furthermore, there is no indication of the approach of saturation in any direction except the ratio of consumers to population. It is true that the average monthly domestic consumption, having increased fourfold within ten years, is now in excess of 100 kilowatt hours; it can double again, however, before the standard at present set by the more progressive municipalities is attained, and might even be multiplied by four and still leave a margin between consumption and the possible demands of electrical appliances now in common use. Before this point is reached, experience indicates that applications of electricity at present comparatively unfamiliar in the average home, will come into popularity, and besides further fields for future expansion will doubtless be opened.

As regards industrial use of electricity, the prospect is for a continuance of growth at a rate at least equal to that of recent years. The value of electrical power as a means of increasing production without commensurate increase of costs, is each year becoming more fully recognized, and the low rates charged for industrial power in Ontario Hydro municipalities afford a strong encouragement to inventors and engineers to develop, and to manufacturers to apply, the means of supplementing the labor of Ontario workmen through the agency of continuously increasing quantities of electrical power. During the year both Federal and Provincial Governments have announced policies of intensive application of scientific industrial research to the problems of manufacturing production, and the stimulus so applied cannot fail to have far-reaching effects in bringing about a more extensive mechanization of industry. The Hydro-Electric Power Commission is prepared to afford its best co-operation, and anticipates a notable increase in the demand for electrical power.

Reduction in Cost of Service

With respect to the cost of service to the consumer, the achievements of the Commission are, it is believed, without parallel. Before the inauguration of Hydro service, the cost of electricity to the residential consumer, for example, ranged in the larger cities of the Province from six to twelve cents per kilowatt hour. Immediately following the introduction of the principle of service "at cost," the charges to consumers became approximately half the former rate. From year to year the cost to the consumer has gradually been reduced, until at the present time more than 80 per cent. of the electrical energy utilized for domestic service is sold in municipalities where the average charge to consumers of this class is less than two cents per kilowatt hour. As an indication of the saving that accrues to Ontario consumers through the low rates charged by the municipalities receiving power from the Commission, attention may be drawn to the fact that, according to The Electrical World of New York, the average charge to domestic consumers in the United States is still

in excess of seven cents per kilowatt hour. In recent years the average cost to the consumer has been reducing in Ontario at a rate of about 4 per cent. per annum.

The rates to commercial and industrial power consumers are similarly low. More than 80 per cent. of the electrical energy utilized for commercial light service is sold in municipalities where the average charge for this service is less than three cents per kilowatt hour. More than 70 per cent. of the electrical power distributed by municipal systems and utilized for power service is sold in municipalities where the average charge to consumers is less than $25 per horsepower per year. This last figure does not include the power sold directly by the Commission to large industrial consumers, which averages in cost about twenty to twenty-one dollars per horsepower per year.

Assured Financial Stability

Notwithstanding the low rates under which the consumers of the co-operating municipalities of Ontario receive their supplies of electrical energy, there has been no departure from the most conservative standards of business administration, and the finances of the system are in an eminently satisfactory condition.

Since the inception of the undertaking, some twenty years ago, the ever-increasing demands for power have necessitated corresponding additions and extensions to the generating, transmitting and distributing systems, until, at the present time, the total investment in plant and other assets incidental to the operation of the undertaking amounts approximately to $284,000,000. During the period of operation of the several systems there have been set aside reserves out of revenue for the purpose of retiring the capital, for renewal of the property and for contingencies and obsolescence amounting, with interest improvement, to about $65,000,000.

Service to Rural Districts

A feature of the Commission's activities which, though of minor importance from the standpoint of the quantities of power involved, is yet of the greatest importance in its relation to the general economic welfare of the Province, lies in the rapid extension of power supply in agricultural areas. The potentialities of electrical power supply on the farm, both for the betterment of social conditions and for the improvement of the economic status of agriculture, are becoming more apparent.

Although the development of rural power supply in Ontario commenced in 1912, the difficulties inherent in the problem of distributing power over a sparsely settled territory at a reasonable cost confined the Commission's early activities largely to the more favorably situated areas in the vicinity of urban centres. Since 1921, however, the Provincial Government had added to its other activities in aid of agriculture, assistance in the form of a "grant-in-aid," defraying 50 per cent. of the capital cost of rural distribution lines and equipment. Concurrently the Commission has developed and standardized highly

economical methods of rural line construction and operation, which have made it possible to formulate a comprehensive scheme whereby the rural areas within reasonable distances of sources of power supply are organized into rural power districts. Service can now be extended wherever within these districts there is a sufficient demand to give the equivalent of three farm contracts per mile of line. The rural residents of the Province have shown an increasing desire to take advantage of the facilities for electrical service thus offered, and the number of consumers in the rural power districts has, since 1922, been practically doubling every two years.

At the end of October, 1927, rural lines were constructed or under construction to serve 25,300 rural consumers in these districts, involving a total of 3,150 miles of line, and a capital expenditure of $6,680,000. The extensions made or under construction during the year were 875 miles, costing $1,919,000 and serving 6,450 rural consumers. In the present fiscal year the Commission plans to construct a mileage of rural distribution lines which, it is expected, will be greater than the whole of the rural systems throughout the Province contained at the end of 1924. This will involve a construction program of over $2,500,000 to supply about 6,600 rural consumers from 1,050 miles of line.

Notwithstanding the comparatively short time most of the rural power districts have been in operation, there has already been a substantial reduction in the cost of service, and this is especially marked where it has been possible to add to the residence and farm loads the power required for rural industries. Every reduction in the cost of service stimulates further expansion, and it may be anticipated that the future will witness a growth in the field of usefulness of electricity as applied to agriculture, compared to which the present rural service may seem to have been but a beginning.

Looking back over the twenty years of the Commission's existence, the record of service to the people of Ontario, constantly widening in scope, is one which stands as a monument to those men of outstanding personality and forehanded judgment who were responsible for the initiation and successful launching of the enterprise. It is the earnest hope and belief of the Commission that 1928 will prove to be the beginning of a second period of service that will in no degree be inferior to that of the past.

Progress of Hydro Development in Canada

THE annual statement of the Honourable Charles Stewart, Minister of the Interior, with regard to the development and use of water-power in Canada, indicates that the great progress made during recent years continued without abatement in 1927 and that with the undertakings now in process of development or in active prospect, the next few years will witness further growth of very substantial proportions.

During the past year hydro-power equipment was installed ready for operation to the extent of more than 221,000 horsepower bringing the total installation in Canada to a figure of 4,778,000 horsepower. In addition other undertakings were advanced to such a stage that a further total of 378,000 horsepower will be in place during the first six or seven months of 1928, thus bringing the total by the middle of the year to more than 5,100,000 horsepower. The remarkable increase which has been made in the past few years is apparent when it is stated that the latter figure is just double the total installation at the end of the year 1920.

Of the activities during 1927, the most significant feature was the increase in electric transmission voltage above that of the lines in the 110,000-volt class which have been operated throughout the Dominion for many years. In this regard the Shawinigan Water and Power Company was the pioneer in constructing a line of 165,000 volts, 135 miles in length, through practically uninhabited territory to carry 100,000 horsepower from the Isle Maligne development on the Saguenay River to Quebec city and vicinity. Construction of another line of still greater voltage was begun during the year by the Ontario Hydro-Electric Power Commission to transmit power more than 200 miles from the Gatineau River in Quebec to the city of Toronto and the Commission's Niagara System. This line is designed to carry more than 250,000 horsepower at 220,000 volts and is expected to be in operation during the autumn months of 1928.

In installations added during 1927 the Province of Quebec took the lead mainly due to the activities of the Gatineau Power Company on the Gatineau River. Hydro-electric construction was also active in Ontario, in the Maritime Provinces, and in Manitoba and British Columbia.

In Quebec the Gatineau Power Company completed the construction of and brought into operation the initial installations of its Chelsea and Farmers Rapids developments, the first of 102,000 horsepower capacity and the second 72,000 horsepower. The Company also vigorously carried forward the construction of a third development on the Gatineau River at Paugan Falls where 204,000 horsepower is being initially installed. For the benefit of these three developments, the Mercier dam creating a very extensive storage reservoir of 95,000,000,000 cubic feet was also completed and the reservoir filled

early in the year under the direction of the Quebec Streams Commission. Additional to its work on the Gatineau River this Company acquired the plants and systems of the Ottawa-Montreal Power Company and the Quebec Southern Power Company, completing the enlargement of the latter's Rawdon plant on the Ouareau River from 300 horsepower to 2,150 horsepower. The Shawinigan Water and Power Company, in addition to building the 165,000-volt transmission line, placed in operation a plant of 4,000 horsepower at St. Alban on the Ste. Anne de la Perade River and started work in connection with the installation of an additional 40,000 horsepower unit at Shawinigan Falls. Other installations placed in operation in Quebec during the year included a 2,000 horsepower unit at Pont Rouge by the Donnacona Paper Company and the completion of a 2,000 horsepower development by the Town of Coaticook. The largest project under construction is the 800,000 horsepower development of the Alcoa Power Company at Chute a Caron on the Saguenay River. Other projects or extensions under way are a 65,000 horsepower development by the Montreal Island Power Company on Des Prairies River near Montreal; the addition of two 10,000 horsepower units to the Canada Northern Power Company's plant on Quinze River; the addition of unit No. 11 of 45,000 horsepower to the Duke-Price development on the Saguenay River; and a 300 horsepower plant by the Cie d'Enterprises Publiques near Riviere a Pierre. Contracts have been let by the City of Sherbrooke for a new development of 5,800 horsepower at Westbury Rapids on the St. Francis River, and the Ottawa River Power Company has authorized the addition of a 25,000 horsepower unit to its development near Bryson on the Ottawa River. The Ontario Paper Company has a plant of 40,000 horsepower under way on the riviere aux Outardes.

The Quebec Streams Commission continued to enhance and encourage power development throughout the province through beneficial work in connection with its extensive storage reservoirs on various rivers.

In Ontario the outstanding work of the year was the commencement of construction by the Ontario Hydro-Electric Power Commission of the 220,000-volt transmission line to carry the 260,000 horsepower which the Commission has contracted to take from the Gatineau Power Company. Actual installations during the year included two plants at Sturgeon Falls and Moose Lake on the Seine River of the Ontario and Minnesota Power Company with 10,000 horsepower and 14,420 horsepower capacities, respectively. A further plant of 13,200 horsepower at Calm Lake on the same river will be completed early in 1928. The Gananoque Electric Light and Water Supply Company added 1,500 horsepower to its Kingston Mills plant, and smaller installations included 325 horsepower by the Town of Smiths Falls and 75 horsepower by the Town of Streetsville. Among the developments under construction is the Ontario Hydro-Electric Power Commission's development at Alexander Landing on the Nipigon River

which when completed will have an installation of 54,000 horsepower. The 56,250 horsepower plant of the Spruce Falls Company at Smoky Falls on the Mattagami River was well advanced, and the International Nickel Company of Canada is commencing the installation of 28,200 horsepower on the Spanish River.

In New Brunswick the Saint John River Power Company made rapid progress on the construction of its 80,000 horsepower development at Grand Falls on the St. John River.

In Nova Scotia, the Nova Scotia Power Commission completed the construction of the 8,000 horsepower Sandy Lake development of its St. Margaret Bay system. The Bridgetown Electric Light Company added 315 horsepower to its plant at Bloody Brook, while the Avon River Power Company has under construction a second hydro-electric plant at Avon River Falls of 4,300 horsepower.

In British Columbia the B.C. Electric Railway Company completed the construction, on the shore of Stave Lake of a 12,500 horsepower plant. The West Kootenay Power and Light Company carried forward the construction of its new 60,000 horsepower development on the Kootenay River at South Slocan.

In Manitoba the Manitoba Power Company completed the superstructure of its Great Falls plant on the Winnipeg River and brought into operation unit No. 4 of 28,000 horsepower capacity.

Numerous undertakings are in the initial stages of construction and others are about to be commenced which will result in an addition to the Dominion total of more than 2,000,000 horsepower, much of which, it is expected, will be in place before the end of 1930. The capital required for this new work will involve the direct investment of at least $200,-000,000, and many times this amount in the application of power to industry and domestic and public use.—*Natural Resources, Canada.*

Electric Strength of Solid Insulation

By W. P. Dobson, Laboratory Engineer, H.E.P.C. of Ont.

(Abstract of Address before Toronto Section, A.I.E.E., November, 1927)

AMONG all the problems which have perplexed the electrical engineer, there is probably none which has received more attention than that of Insulation. It has increased in importance with progress towards larger systems and higher voltages and it can scarcely be denied that it is the most important problem which now faces the industry.

The effort of physicists and engineers have, for many years, been devoted to the task of discovering and explaining the fundamental phenomena of insulation under electrical stress, and of deriving general laws of behaviour which may be used in the design of apparatus and systems. Progress towards the solution of these problems has been slow. Although a vast fund of knowledge has been accumulated concerning the properties of many types of insulation in common use, yet general laws have been derived only in the case of air and these do not completely explain all the phenomena observed. Liquids and solids appear to behave in a manner quite different from gases and no general law applicable to insulation as a whole has been discovered. The situation is thus very unsatisfactory in comparison with that in other fields such, for example, as magnetism in which general laws have been established. The reason for this condition probably resides in the variety of structure of insulating materials. These efforts have, however, resulted in a clearer understanding of the phenomena of insulation and have indicated in what direction progress may be expected. It is generally agreed that an understanding of the mechanism of breakdown is necessary to a complete solution of the problem.

Since the failure of any particular insulation usually occurs at a definite voltage, the earliest efforts to explain breakdown proceeded from the assumption that it was a voltage phenomenon. Consequently, the "electric strength" or "dielectric strength" of insulation has been the subject of much investigation and it has served as a fairly satisfactory practical criterion of quality. Its value for any insulation depends upon many factors such as the type of electrodes and the dimensions and form of the sample; it is therefore not a fundamental property, although it appears to be the quantity which yields most valuable information regarding the mechanism of breakdown.

The laws of dielectric strength have been established for air and a fairly satisfactory theory has been evolved to account for its breakdown under electrical stress. These results are not applicable as yet to liquid and solid dielectrics. It is therefore necessary to establish the experimental facts of the behaviour of liquids and solids under electrical stress, to reconcile them, if possible, with the behaviour of gases and to evolve a

theory which will acount for all the phenomena. This is the problem of insulation.

It seems natural to expect that dielectric strength should be proportional to thickness but this is not so except over a limited range. In the case of solids a relation of the following form:

$$E = AT^n$$

has been established where E is the breakdown voltage, T is the thickness, A a constant.

The index n varies with the material and time of application of stress and assumes values from 0.5 to 0.7.

This relation does not hold for liquids—in fact, no definite relation has been agreed upon.

Area of Insulation

Large variations occur in the dielectric strength of solid sheet materials depending on the area of the test electrodes. Small electrodes (1/64 in.) yield results 40 to 50 percent higher than large electrodes (10 in.). These discrepancies remain unexplained. Similar results for liquids are not available.

An increase in temperature causes a decrease in the dielectric strength of most solids, but in the case of liquids the results are not consistent. Transformer oil increases in strength up to 50° C. and beyond this shows a slight decrease. Fig. 1 shows the relation for porcelain.

Duration of Voltage Application

The effect of electrical stress upon solid insulation appears to be cumulative; in other words the voltage required to puncture a specimen if applied continuously for ten seconds is greater than that which would cause failure in sixty seconds.

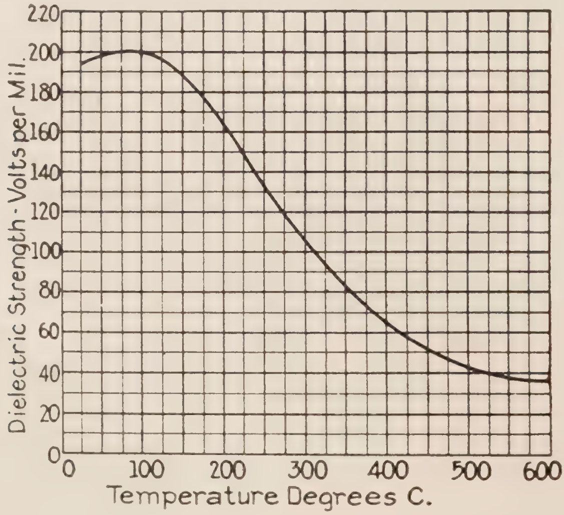


Fig. 1. Decrease in dielectric strength of wet process porcelain with increase in temperature.

The relation is of the form:

$$E = A + \frac{B}{\sqrt[4]{T}}$$

where A and B are constants and T is the time.

The effect of an increase in frequency is to decrease the dielectric strength of solids. The relation is of the form:

$$E = \frac{A}{f^n}$$

where f is the frequency.

Rate of Application of Stress

In general, the dielectric strength of solids increases with the rapidity of application of voltage. This is explained as being due to the time-lag of insulation, i.e., the time during which the stress must act before it can puncture the insulation. A voltage of this kind is an impulse and is equivalent to a quickly established unidirectional voltage.

Difference Between a.c. and d.c. Stress

For air, the crest value of the alternating voltage required to cause rupture is the same as the value of direct voltage. For solids the dielectric strength under direct stress is greater than that under alternating. The ratio of d.c. to a.c. breakdown varies with temperature, thickness of sample and rate of application of stress. For liquids, the results are inconsistent; transformer oil exhibits greater strength under a.c. stress, petrolatum shows greater strength at 50 cycles and less at 60 cycles than under d.c. stress.

It has been discovered that many solids, after being subjected to repeated applications of voltage, will deteriorate and show a decreased dielectric strength. The effect upon the strength depends on the number and duration of the repetitions of stress. If the stress be applied continuously the deteriorating effect is greater and the dielectric strength much decreased.

Theories of Breakdown

The first attempts to explain the breakdown of insulation were based on analogy with mechanical rupture. As iron or steel fails when a definite mechanical stress (lbs. per sq. inch) is reached, it was inferred that an insulating material would fail when a definite electrical stress (kv. per cm.) was reached. A consideration of the experimental results cited above will indicate that this simple theory is not sufficient.

It was stated above that the laws of breakdown for air had been established. The breakdown of air has been qualitatively explained by means of the theory of ionization by collision, but this has not been successfully applied to liquids or solids.

The first partially successful attempt to explain the breakdown of solids was based on the conception that it was a combined electrical and thermal phenomenon, hence the name. To understand this theory it is necessary to remember that solid insulators are heterogeneous in structure and that their electrical resistance decreases with increase in temperature.

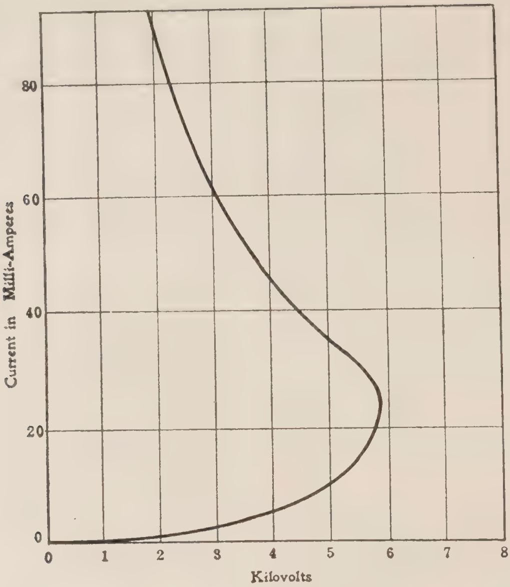


Fig. 2. Volt-ampere characteristic of impregnated paper. Breaddown value at 5.8 kv.

The application of electrical stress will cause a small current to flow through the insulation and assuming the existence of spots or filaments of lower conductivity than the surrounding mass, the current density will be greater at these points than elsewhere and hot spots will be produced. The resistance will then decrease and the current in consequence increase, further raising the temperature of the spots and decreasing the resistance. Unless the heat can be conducted away by the surrounding mass the temperature and current will increase until the material burns and breaks down. This theory has been investigated mathematically and experimentally and found incompetent to explain fully the phenomena of breakdown. An extension of the theory taking into account variations in specific inductive capacity has been recently proposed.

The Electron Theory

Since this theory aims to explain the ultimate structure of matter, it should be capable of application to the problem of breakdown but for this application the engineer must wait until the physicist has discovered the atomic structure of chemical compounds entering into the materials of insulation and this appears to be a prospect for the dim future.

Dielectric Failure as a Condition of Instability

Perhaps the most plausible theory is that which considers it as a phenomenon of circuit instability. On this theory the constants of the circuit (including the insulation) may undergo change as a result of electrical

stress and instability is revealed by an increase in current accompanied by a decrease in voltage. This phenomenon appears at breakdown and results from the form of the stress—current density curve (Fig. 2). The point of breakdown is indicated by the maximum value of stress. This theory has not been developed as yet theoretically and until this has been done it cannot be checked by experiment.

This discussion of the problem of insulation leads to the following conclusions:

(1) Our knowledge of the properties of insulating materials is inadequate. Further experimental work is necessary to establish laws governing their behaviour. Existing results are not consistent.

(2) No general laws have been discovered, as in magnetism.

(3) The theories of breakdown which have been applied successfully to air do not appear to be applicable to liquids and solids.

(4) Breakdown is not caused by electrical stress alone: thermal effects and changes in circuit constants also appear.

(5) The mechanism of breakdown cannot be explained completely until the structure of the atom is fully understood.

(6) The engineer must seek for bulk laws upon which to base designs involving insulating materials.

Electrical Burns and Electrical Shock

By R. E. Gaby, B.A., M.D., Consulting Surgeon, H.E.P.C. of Ont.

(Read before the Academy of Medicine, Toronto, March 1, 1927)

THE incidence of electrical accidents is apparently on the increase, because of the greater use of electricity in the industries and the household. While instruction as to the attendant hazards, the use of safety devices, and instruction and exercise in resuscitation methods have kept down the injuries and death among electrical workers, there apparently seems to be a lack of information on such subjects among the public. Electrical accidents are partly an engineering problem, and partly a medical problem. From the medical standpoint, the electrical accident may be subdivided into several phases, viz.:

1. Electrical shock.
2. Electrical burns.
3. Associated traumatic conditions (such as wounds, fractures and other types of injury.)
4. Complications of electrical injury (such as paralyses, organic and functional.)
5. Sequelæ of electrical injuries (scars and deformities—psychoses and neuroses, neurasthenia, melancholia.)
6. Death.

The electrical accident is caused by the individual coming in direct or indirect contact with a conductor of electricity. Indirect contact is made by means of an intervening object such as the string of a kite, dusters, air, etc. The immediate result of this contact is an electrical shock of a greater or lesser degree, with or without external injuries.

The electrical shock may be accompanied by unconsciousness of varying duration, by symptoms which we usually associate with surgical shock, or death may result. The effects of the passage of electrical current are: rigidity of the muscles, more or less generalized; interference with respiration, or even paralysis of the respiratory centre; excitation of the central nervous system; spasm of blood vessels, with congestion and œdema. The exact mechanism of death from electrical shock is still uncertain. Much experimental work has been carried on, and it is hoped that in the near future we may have something definite as to causation. At present, it is thought that death may be due to, either a paralysis of the respiratory and vasomotor centres or to ventricular fibrillation. There are various theories as to the relation of high and low voltages, paths of current, etc., as affecting the manner of death. However, the different effects, fatal or non-fatal, depend upon various factors, such as:

1. The type of current, whether alternating or direct; alternating currents doing greater damage.

2. The voltage, whether high or low tension. It has been said that death from low voltage current is due to ventricular fibrillation, and from high voltage, to respiratory centre paralysis.

3. Duration of contact.

4. Point of contact and path of current. It is said that if the course of the current is from head to foot the current fails to affect the heart, while if through the chest the heart is involved. However, our clinical experience does not absolutely agree with these statements. The degree of injury is probably more or less proportionate to a combination of amperage and voltage and the duration of the contact.

5. Condition of contact. Where the resistance of the skin is lowered, and where a good ground is made, the local injuries are probably very slight, while the systemic injuries are usually grave.

6. Concentration of current. The size of the electrode, or surface of contact, determines this concentration, the concentration being in inverse proportion to the contact.

7. Character of grounding.

8. Personal toleration. *E.g.*, status thymolymphaticus. It is also claimed that expectation or attention have an effect on the injuries received, though this is very doubtful.

In about 90 per cent. of the accidents, the main injuries are from burns, and not from shock. The burns may be of several types:

1. The true electrical burn caused by contact with the conductor.

2. Burns caused by the intense heat generated by short circuiting, the so-called "flash" or "arc" burn.

3. Clothing burns, caused by the ignition of the clothing by the arcing.

This last is of the type of the ordinary burn. The second type is usually more severe on account of the extreme heat generated, and blistering is not so common as is the ordinary burn.

In the true electrical burn the degree of contact and the resistance of the skin determine the amount of local injury. The latter varies from 3,000 to 5,000 ohms, but may be as low as 1,000 ohms. The resistance of the skin depends upon its thickness and its state of cleanliness and dryness. It is less when the skin is wet, as by perspiration or external moisture, or when it is dirty. The chief resistance is in the skin, and the remaining body resistance can be neglected in the passage of the current through the body. The various animal tissues offer resistance in the following order, bone, fat, tendon, skin, muscles, blood and nerve. The blood vessels are good conductors and this may possibly explain the frequency of thrombosis more or less remote from the site of contact. If the resistance of the skin be low, and the contact good, the current passes readily into the body causing severe systemic disturbance with little or no change at the point of contact. The greater resistance of the skin and the duration of contact, the more severe the burns. The burns take place at the points of resistance and so are found at the points of entrance and exit of the current. The electric burn varies from the smallest spot to the complete destruction of a limb, or part of it, or of large masses of tissue including bone. The small electrical burn is a burn of fourth degree, more or less circular in shape, pale yellow in colour, bloodless, cold and painless. The edges of the burn are slightly

higher than the surrounding skin; the centre is depressed or excavated, possibly distinctly charred as if punctured by a red hot wire, producing a deep sinus. There is no reddening or blistering of the skin in the vicinity; the base of the burn is ragged and irregular and is strongly united to the subjacent tissues and remains unchanged for days or weeks. It gradually starts to loosen and may come away *in toto* or in pieces by a process of aseptic necrosis. Pus formation is exceptional. There may be one or more such electrical spots at the points of entrance or exit. In the severe types of burns we have areas of charring and carbonization, down to and including the bone. In the case of the hand, the hands are fixed in a position of complete flexion with complete charring of skin and flexor tendons, or even bone. Within twenty-four to thirty-six hours the surrounding skin is slightly reddened and the deeper tissues more or less œdematous. In the case of an extremity, it becomes markedly swollen for a considerable distance beyond the site of burn or the whole limb or greater portion of it may become gangrenous as a result of remote thrombosis. This may occur both in the extremity, at the site of entrance, or in the extremity through which the current emerged. Occasionally, skin apparently not damaged to any extent, after several days, will rapidly show necrotic changes and finally slough. A similar phenomenon occasionally takes place after the burns are entirely healed. Ulceration may take place, and considerable time is required for this to re-heal. The underlying muscles are often paralyzed, and frequently are involved in the sloughing because of the coagulation of myosin by the heat. Sensory changes from a paræsthesia to a complete anæsthesia may occur.

The severity of an electrical burn is at first generally under-estimated; the duration of the time required for healing is also under-estimated. It usually takes about two to three times the healing time of the ordinary burn. There are definite vascular changes, consisting of a disintegration of the media, the lumen remaining intact and the blood in the neighbourhood remaining fluid. This weakening of the vessel wall results in often serious hæmorrhages, and may occur at some distance from the site of the apparent burn. Operative interference in an apparently healthy site may result in severe secondary hæmorrhage without any infection being present. There is also a tendency to peripheral thrombosis, angiospasm, and œdema. One must be guarded then in prognosis, both as to the extent of burns and to the duration of the time necessary for healing. One must also be conservative in any surgical interference before one is certain of the limits of the injury. Suppuration is not common and consequently the degree of toxæmia from an electrical burn is usually not so great as from an ordinary burn of the same degree and extent.

Electrical flash burns of the face are not infrequently followed by traumatic cataract, and ocasionally by optic nerve atrophy.

There are no gross lesions within the body absolutely indicative of

death by electrical shock. Petechial hæmorrhages in the brain stem and fragmentation of the heart muscle have been described as pathognomonnic. There is frequently an anuria, and red blood cells are usually present for the first few days in any urine passed. Leucocytosis is present. There is a blood concentration which may be an important factor in subsequent death, as it is in ordinary burns. The complications are the same as in the case of ordinary burns. The toxæmia, however, is apparently not so severe. The resulting deformities and contractural and cicatricial disability are often very great.

The Cause of Death From Electrical Shock

The cause of death from electrical shock still remains a not absolutely solved problem. There have been two theories:

1. Ventricular Fibrillation, Bourruta, in 1918, claiming that 90 per cent. of the deaths were from this cause, and

2. Paralysis of the Respiratory Centre. Jellinek claims that death from electrical shock is only an apparent death and not associated with fibrillation. More recent observations and experimental work seem to show that the deaths are more largely due to respiratory and vaso-motor centre paralysis, or block. At first these centres are refractory to external stimuli, and oxygenation of the blood must be carried on by artificial means, until such time as the centre recovers or death intervenes. Because of the belief that electrical shocks are fatal and ventricular fibrillation is always produced, resuscitation is not started, or is not carried on sufficiently intelligently or long enough to resuscitate the victim. In spite of publicity, occasionally a medical practitioner called on to handle a case of electrical shock is apparently not aware of the necessity of artificial respiration.

In ventricular fibrillation, the respiratory centre is usually not affected. Respirations continue, becoming exaggerated from asphyxia, then fail entirely. In man, they may continue from one to two minutes. Spontaneous recovery from ventricular fibrillation may occur and is probably not uncommon in man. It cannot occur after a longer period than two minutes. Ten minutes is the maximum time that nerve centres can be deprived of blood, and usually five minutes is the standard time allowed. Hence, even in cases of ventricular fibrillation, artificial respiration should be commenced, as there is always a possibility of spontaneous recovery.

In respiratory centre paralysis, the respirations are suspended, the heart continues, the pulse may be feeble and hardly obtainable; there is a great fall in the blood pressure, the skin is moist cold and cyanotic. The necessity for artificial respiration is apparent. The centre will not respond to stimuli from afferent nerves. The vasomotor centre is similarly affected. Central stimulation of the cut vagus nerve has no effect on the cardiac centre. E. Grange (1882) was the first to describe a case of death due to industrial electricity and later he, Brouardel, and Garnet, started experimental work to determine the

important factors in such cases. D'Arsonval made more extensive researches, and in 1886 advocated that the same methods of resuscitation as are used for drowning should be applied to apparent death from electricity.

Resuscitation After Electrical Shock

By Wills Maclachlan, Electrical Engineer, Toronto, Ont.

(Read before the Academy of Medicine, Toronto, March 1, 1927)

THE general use of electricity has brought about two special types of injury, *viz.*, that of electrical burn and electrical shock. In the development of the industry, great care has been exercised to reduce these hazards to a minimum. There has been, however, an increase in injuries among non-electrical workers and members of the public, due principally to ignorance of the danger, or to the use of non-approved appliances, or the use of appliances in a non-approved method. In its own work, the electrical industry has used every care in design and construction, has carried out instruction and training of its employees in safe methods, and has interested itself in examination and research as to ways and means to prevent electrical accidents, and as to remedial measures to be put into effect should they occur. In the development of this research, the literature on the subject of electrical shock and resuscitation has received most careful consideration. This literature, though possibly not extremely extensive, yet contains many able papers, a list of the most important appearing as an appendix.

The pertinent points as to the present knowledge of the effects of electrical current on passing through the body may be summed up as follows:

1. The effect of the shock is greatly increased if the points of contact between the body and the electrical conductors are good, or, in other words, the effect will be greater if wet hands are placed on electrical conductors than if dry hands are placed, hence the fatal shocks in bathrooms from comparatively low voltages.

2. The path of the current through the body has a decided effect on the shock. If a shock be received from foot to foot, the effect will be immeasurably less than if received from head to foot, hand to foot or head to hand. Where the path of the current lies through the medulla or thorax the effect (other things being equal) will be greatest.

3. The amperage of the current passing through the body has a distinct effect on the shock. Hence, with the same condition of points of contact and duration of contact, the effects from higher voltages are greater.

4. The duration of the contact has an effect on the shock, as it is shown

that the heart does not beat during the period of contact.

5. The passage of the current through the body may have a permanent effect on the heart. There may be a temporary inhibition, or damage of the heart muscle, or ventricular fibrillation may be set up. The exact nature of these effects is not known and research is needed to clear up the problem.

6. The passage of the current causes a profound paresis or inhibition of the respiratory function. This inhibition is at or near the respiratory centre and may not be permanent. As to the exact nature of the lesion little, if anything, is known.

7. The passage of the current causes an inhibition of the vaso-motor system, particularly the vasoconstrictors. The nature of this inhibition or block is not known.

8. From the time of the passage of the current until the return of the eye reflex, the brain is insensitive to extraneous influences, such as stimulation of the central end of the cut vagus or cut sciatic. Hence, many of the usual tests for life fail.

To sum up: after the passage of the current, the patient is unconscious and not breathing. The pulse cannot be felt at the wrist or temple, and at times the heart beat cannot be heard with the stethescope. Many of the usual tests for life give negative results. The pupils are dilated and the skin cold and moist. At times the body is rigid.

In a patient in this condition, resuscitation is clearly indicated as a remedial measure. By resuscitation, the lungs will be ventilated, venous blood will be forced to the heart and will not be allowed to stagnate in the abdomen as a result of the inhibition of the vasoconstrictor nerves; rhythmic pressure will be maintained, causing a massage of the heart, and having an effect on the return of voluntary breathing. By the ventilation of the lungs and maintenance of the circulation, oxygenated blood is carried to the respiratory centre, and if gross damage has not resulted from the passage of the current or from lack of oxygenated blood over a period, this supply of oxygen to the centre will aid in removing the block.

Immediately on being cleared from the current, the patient is placed in a prone position, the mouth and throat cleared of any foreign substance, and the tongue brought forward. The arms are placed above the head to expand the chest. One arm is bent at the elbow and the head rested on the forearm to keep the mouth out of any dirt. The head is turned on one side, the face being away from the crook of the bent elbow so that the nose and mouth are free for breathing and in a position that they may be easily cleared.

The operator will straddle the patient, the knees in such position that when the operator is in the pressure position, the thigh is perpendicular to the floor. The operator will place the hands on the small of the back with thumbs alongside the fingers and hands turned outward, the little finger resting on the lowest rib. This will place the hands so that they are over the three lowest ribs. As these ribs are not attached directly to the sternum and are flexible, move-

Fig. 1

ment of the ribs is obtained with moderate pressure. This movement is greatest if the hands are placed as far apart on the back as is possible without slipping off. (See Fig. 1.)

With the hands in this position, the operator kneels forward until his thigh is perpendicular to the floor and his shoulders are directly over his hands. Care must be exercised to keep the arms straight and rigid in this position. If these instructions are carried out maximum pressure with minimum effort is obtained. (See fig. 2.)

When pressure is exerted on the

Fig. 2

Fig. 3

three lowest ribs in this manner, the liver, spleen, and stomach are elevated and so bring pressure on the diaphragm elevating it and thus compressing the chest and causing an expiration. At the same time, during the pressure, blood is forced from the abdomen through the veins toward the heart, thus aiding in maintaining the circulation. This movement of blood from the large vessels of the abdomen to the heart also offsets the effect of the inhibition of the vaso-constrictor nerve system.

The pressure is then removed from the back by the operator rocking back on his knees, sitting on his heels, removing his hands from the back and allowing his arms to fall in a relaxed position of rest. (See Fig. 3.) By the removal of the pressure, the ribs assume their normal position, the liver, spleen, and stomach descend, followed by the diaphragm, resulting in an inspiratory movement of the lungs. It is clearly seen that the expiratory and inspiratory movements of the lungs are brought about by the diaphragm in a manner closely approximating the mechanics of normal breathing. This cannot be said of any method of resuscitation except the Prone Pressure Method.

Due to the necessity at times of continuing resuscitation over comparatively long periods, it is important to provide periods of rest for the operator. Even in short cases of from ten to thirty minutes of resuscitation, the operation, due to the movements and to the possible excitement, may be very fatiguing. It is also important to be certain to entirely remove the pressure from the back. The operator is therefore instructed to entirely remove his hands from the back of the patient, sit back on his heels and drop his arms in a relaxed position.

After a pause, he will kneel forward and bring pressure to bear in a similar manner. The alternating of pressure

and removal being carried out from twelve to eighteen times per minute. In teaching resuscitation, it is advisable to maintain a rhythm of ten to the minute and during practice to insist on the rate of ten, as the great tendency is to go too fast.

During the continuance of the resuscitation, the mouth and throat of the patient should be kept clear. Every endeavour should be carried out to maintain the warmth of the patient by blankets, hot water bottles, and other suitable means. These attentions, however, must not interfere with the efficient continuance of the resuscitation.

In regard to the use of stimulants by hypodermic during the continuance of resuscitation, little of a definite nature can be said. Many stimulants have been tried, the beneficial results being extremely doubtful. At the present time, there is a feeling developing in the minds of those most closely associated with the treatment of electrical shock cases, that the use of hypodermics militates against the successful issue of the case. Administration of adrenalin directly into the heart muscle, using a needle at least three inches long, may have a beneficial result but even this has not been proved. It may be said that the administration of stimulants by hypodermic is not an important therapy in electric shock cases.

The continuation of resuscitation, if necessary, over long periods, is of the utmost importance. It has been proved that from the time of the passage of the current until the return of the eye reflex, the brain is insensitive to extraneous influences. Hence, as stated above, many of the usual tests for life may fail. There are many cases on record of the successful resuscitation of persons from electrical shock by the efficient application of the Prone Pressure Resuscitation Method over periods of upwards of three hours, during this time little or no indication being given that the patients were alive. "Nothing less than the cooling of the body or the onset of rigor mortis should be taken to be evidence of death."

On the return of voluntary breathing, the operator must endeavour to bring his rhythm into synchronism with the breathing of the patient. It has been found that the voluntary breathing often has the same rhythm as the resuscitation and every endeavour should be made not to interfere with the first feeble efforts. The patient, on recovering breathing after electrical shock, will very often start to struggle and attempt to get up. He must be kept lying down and on no account allowed to rise. As soon as consciousness returns, it is a simple matter to have him lie still, but, before this, force may be necessary. It is quite apparent that with an inhibition of the vasoconstrictor nerve system, if the patient be allowed to sit up or stand up, there is danger of the blood remaining in the large blood vessels of the abdomen bringing about a serious syncope.

If it becomes important for any reason to move the patient before the return of voluntary breathing, this must be done in such a manner that the patient is lying prone and that resuscitation may be carried out during transportation. It is well to

emphasize the fact that resuscitation cannot be carried on on a patient lying on a stretcher. To transport a patient after voluntary breathing has returned, provision should be made so that he can lie down in a comfortable position in such a conveyance as an ambulance, truck, or express cart. Under no circumstance should he be transported sitting up in a motor.

In training employees or others in resuscitation, it is important that the effects of drowning, gas poisoning, and electrical shock, be explained in as simple terms as possible. The mechanics of the act of breathing should then be explained using as few technical terms as a clear explanation will permit. The exact detail of resuscitation should then be demonstrated using one of the class as a patient. The class should then be paired off and half the class lie down as victims, the operators being instructed in each step to be taken, in carrying out the resuscitation. After the instruction of half the class, the exchange of operator and patient is carried out and the other half instructed. It is well then to carry out another demonstration, as it assists the class to notice their mistakes. Usually, many questions will be asked about various points. Definite arrangements should be made to have regular practices in resuscitation. The employees in the electrical public utility industry are required to practise resuscitation twice a month. Records of these practices are kept with details of attendance. These records are carefully checked and followed up where necessary. During the practices, the men are taught to change from one operator to a relief operator without losing a stroke or the rhythm. Also, other matters of importance in an emergency are explained.

In the electrical public utility, the employees are often working many miles from the head office and arrangements must be made to efficiently handle any emergency. Clear and explicit instructions are prepared as to telephone advice, to responsible officials, calling of medical help, preparing to care for the patient, and providing consulting advice by telephone. In certain remote plants special supplies are available for the doctor when he arrives. Every endeavour has been made to anticipate the requirements for dealing with the case by the men and for assisting the doctor when he arrives. The doctor can greatly assist by sustaining the morale of the men and by encouraging them in their efforts, as it is well recognized that they very likely will be nervous and excited.

On the afternoon of May 22, 1926, an operator in one of the power houses in Ontario, was cleaning a window and in a moment of thoughtlessness brought his head in contact with a 22,000 volt bus, receiving the current from head to hand and leg. He fell back in an unconscious condition and appeared lifeless. Fellow employees immediately de-energized the bus-bar and surrounding apparatus, lowered the man to the floor, and one of them started prone pressure resuscitation. Other employees telephoned for a doctor to a town a few miles distant, and, although the roads were in very bad condition and there was a very

bad hill to come down, other members of the staff brought the doctor to the power house and also brought nurses. At the same time, long distance communication was set up with those in charge of the work in Toronto and with the Medical Consultant. By the time the doctor had arrived, resuscitation had been carried on for sometime and the patient started to breathe voluntarily about thirty minutes after the accident. As a result of consultation over long distance, the patient was put to bed in one of the employee's houses near the power house, under the care of the nurses and doctor, and received the necessary first-aid treatment for his burns. After a few days, it was found possible to move him and with the usual assistance he was brought to the Toronto General Hospital where he has been receiving care under Dr. R. E. Gaby. The details of the progress of the case in the hospital have been given in a paper by Dr. Gaby.

This is a simple statement of the handling of a severe case of electrical shock and burns, and it is rather typical of cases that have, unfortunately, happened in various parts of the province.

Where do we stand at the present time in connection with the treatment of electrical shock? As far as is known the passage of an electrical current through the body at times has a direct cardiac effect, this apparently being either an effect on the heart muscle, or in the setting up of ventricular fibrillation. The exact details in connection with the effect of the electrical shock on the heart have not, up to the present, been exhaustively investigated. Another effect is to cause a profound inhibition or block of the vital centres of the brain, particularly the respiratory centre, the vagus centre and, the vaso-motor centre. By the application of artificial respiration, the lungs are ventilated, and venous blood from the liver, spleen, and stomach is forced toward the heart. By the continued application of resuscitation, the ventilation of the lungs is kept up until the temporary paresis or inhibition of the respiratory centre passes off, when the breathing becomes voluntary, the procedure may be stopped. One naturally asks: What is the nature of this block in the vital centres of the brain, and what can be done to lessen the time of this profound inhibition or temporary paresis? So far as is known at the present time, nobody has answered these questions. I may be anticipating, but I have great hopes that it will be answered sometime within the next year or so, and I sincerely hope it will be answered in Toronto. This can only come as a result of the close co-operation between members of the Engineering and Medical Professions. If each will bring to the problem the background of his profession, as well as the specialized technique in methods of analysis and control, they will jointly be able to solve what appears to be a baffling problem.

In the meantime, since our men are thoroughly trained in the latest technique, is it too much to ask for co-operation and support?

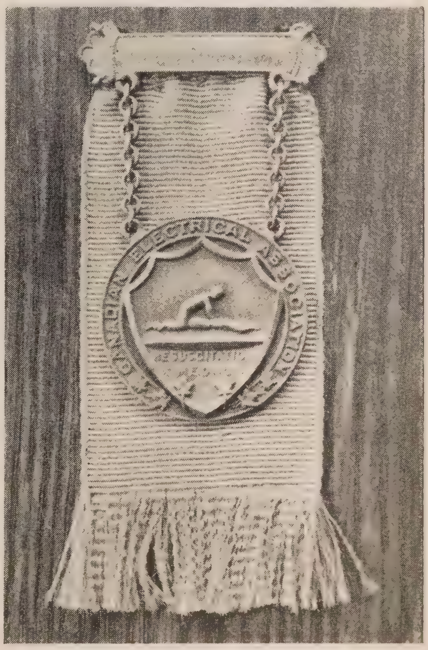
BIBLIOGRAPHY

1. JEX-BLAKE, A. J., *Brit. M. J.* March 1, 8, 15 and 22, 1913.

2. Cannon, W. B., Resuscitation Commission, *Tr. Nat. Elect. Light Ass.*, 1913.
3. Meltzer, S. J., *Ibid.*, 1919.
4. Reports of Accident Prevention Committee, *Ibid.*
5. Drinker, C. K., *Tr. Am. Gas Ass.*, 1923.
6. Schafer, A. E., *Proc. Roy. Soc. Edin.*, 1903. *Proc. Roy. M. & Chir. Soc.* 1903-1904. Artificial resuscitation in man. *Harvey Lectures*, 1907-1908.
7. Lauffer, C. A., Resuscitation, John Wiley & Sons, New York, 1915.
8. Keith, Arthur, *Lancet*, 1909.
9. Drinker, C. K., *J. Indust. Hyg.*, 1923, v. 255.
10. Meltzer, S. J., *Med. Rec.*, July, 1917, xcii, 1.
11. Prevost, J. L., Cited in (1) *Rev. Med. Suisse Rom.*, 1898, xv.
12. Battelli, F., Cited in (1) *Rev. Med. Suisse Rom.*, 1899, xix. Congress Internat d'Elec. Berne, 1902. Rochet's Dict. de Physiologie, Paris, 1904, vi.
13. Jellinek, S., *Arch. Radiol. & Electrotherap.*, 1922-1923, xxvii, 316.
14. Legge, T. M., *Arch. Radiol. & Electrotherap.*, 1922-1923, xxvii, 1.
15. MacWilliam, J. A., *Proc. Roy. Soc. Med.* 1922, 15, parts 1-2; *Electro-Therap.*, p. 49
16. Ram, S., *Arch. Radiol. & Electrotherap.*, 1922-1923, xxvii, 4.
17. Campbell, A., and Hill, L., *J. Indust. Hyg.*, 1924, vi, 260. Symposium of resuscitation, *J. Am. M. Ass.* Sep. 6, 1924, lxxxiii, 756-765.
1 . Urquhart, R. W. Ian, *J. Indust. Hyg.*, April, 1927, ix, No. 4.

Recuscitation Medal Presented at Sarnia

ON May 20th, 1927, Mr. Harold Hedges, a lineman in the Sarnia Rural Power District, in carrying out his work as a lineman received a shock of 26,400 volts to ground. He was rendered unconscious and not breathing. Assistance was quickly given by other members of the line gang and he was removed from the pole and resuscitation started. After Dr. C. M. Carruthers was called, he was removed to the hospital in Sarnia in an ambulance resuscitation being carried on during the transportation and in the hospital. Assistance was given in resuscitation not only by the members of the Sarnia Rural Power District, but also by the line gang of the Sarnia Hydro-Electric System, and certain operators from the Operating Department of the Hydro-Electric Power Commission operating Sarnia substation. It was necessary to use these different men as resuscitation had to be maintained from two o'clock in the afternoon when the accident occurred, until ten o'clock at night, when Hedges began to breathe of his own volition. This is the longest case of resuscitation from electrical shock that there is a record of, either in America or any



Canadian Electrical Association Resuscitation Medal

Group Photograph taken after the Presentation

other part of the world, and is an outstanding evidence that quick and continuous application of resuscitation by trained and experienced men will, in cases where it seems almost impossible to resuscitate, result at times in success.

The matter was reported to the Canadian Electrical Association and two resuscitation medals were awarded, these being presented in Sarnia by Mr. Wills Maclachlan, representing the President of the Canadian Electrical Association.

After the presentation a group photograph was taken of Mr. Hedges, together with those who carried out the successful resuscitation, and some of those present at the presentation of the medals. Mr. Hedges will be seen sitting in the centre of the photograph, Mr. Storey, the Superintendent of the Sarnia Rural Power District, being on his left hand, Mr. McMann, the foreman for the Sarnia Hydro-Electric System, being on his right hand.

Mr. R. R. Cousins, immediately to the left of Mr. Storey, is the holder of a Canadian Electrical Association medal, individually having at a previous time won this medal, and he also was very prominent in this resuscitation.

Notes of Interest

Messrs. Higgins, Van Ness and Gisiger, engineers of the Pennsylvania Water and Power Company, Baltimore, Md., spent two days with the Commission's engineers recently at Toronto and Niagara Falls. This Company has in hand a large hydro-electric development on the Susquehanna River and their engineers are visiting the larger plants in Cana-

da for the purpose of securing ideas. Mr. Higgins in thanking the Commission stated: "We regard our discussion of our plans, practices and experience with you and your engineers, to be among the most profitable of our trip. We enjoyed every minute of our day in the Niagara District and especially the Queenston Plant.

Such intercourse and co-operation between engineers and officials of different organizations in similar lines of endeavour result in benefits to all parties.

* * * *

A farewell dinner was given at Hart House, University of Toronto, on December 29, 1926, in the honour of Mr. J. A. Knight, who recently left the Hydraulic Department of this Commission to take an important position on the Engineering staff of the Aluminum Co. of Canada, Limited, at Arvida, Que. The dinner was given by the Toronto Branch of the Engineering Institute of Canada, of which organization Mr. Knight was Vice-Chairman. Mr. Knight and his associates will be engaged upon the design of the proposed development at Chute a Caron, Que.

Three other Hydro men who have also joined the Engineering staff of this Company in connection with its Hydro developments are: Messrs. G. O. Vogan, Ross M. Carmichael and Robert Morham.

The Bulletin wishes all of the above former members of the Commission staff every success in their new endeavours.

An invitation has been received from Mr. H. M. Johnson, Chairman Meter Committee, New England Section, National Electric Light Association, asking that representatives from this Commission attend a group meeting of this section to be held at Boston on February 7th and 8th. A subject for discussion at this meeting will be "Totalizing and remote metering methods," and our representatives are asked to give an outline of the various systems for accomplishing this as applied to power.

* * * *

We have received a letter from Mr. H. F. Gurney, Officer-in-Charge, His Majesty's Trade Commissioner, enclosing a copy of letter to the Department of Overseas Trade, London, England, by Mr. H. Hemming, Managing Director, Aircraft Operating Co. Ltd., and enclosing a clipping of a letter from Mr. Hemming to the London Times. Mr. Hemming's letter to the Times comments on an article that appeared in the October Bulletin describing the aerial survey for the Toronto-Gatineau Transmission Line which we quote in the following:

To the Editor of the Times:

Sir:-

In view of the interest which is now being taken in air surveying, and also in connection with the proposed development of electric power in this country, may I call attention to an article which appeared in the October Bulletin, No. 10, issued by the Hydro-Electric Power Commission of Ontario? In this article, Mr. A. C.

Goodwin, engineer of the Transmission Department, H.E.P.C. of Ontario, describes how the Commission successfully employed the air survey method for locating and purchasing easements for the 200-mile 220,000-volt line now under construction from Fitzroy Harbour, on the Ottawa River to Toronto. The following interesting facts are extracted from the article:- (The letter here gives a brief description of the survey as outlined in the Bulletin article).

The article which is illustrated, is of particular interest as coming from an independent authority and dealing with work which has been successfully carried out. It provides further evidence of the great value that air survey can be to the development of the Empire.

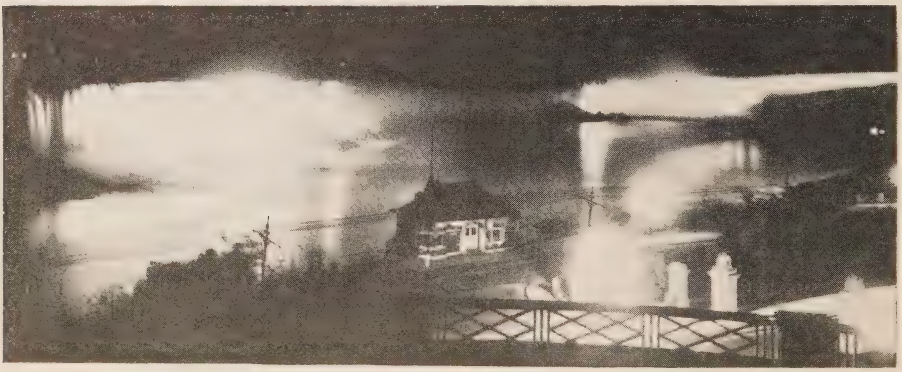
I am, Sir, your obedient servant,

H. Hemming, managing Director

The Aircraft Operating Company, Limited,
8, New-square, Lincoln's Inn
November 24. W.C.2,

Mr. W. H. McMackon, whose death at his home 522 Marion Street, Toronto, took place on January 3rd will be recalled by many former electrical associates. He owned and operated the electric light plant at Ridgetown from 1899 to 1912 when he sold it to the Town, but continued as Manager until the local plant became part of the Hydro System. Mr. McMackon was the father-in-law of D. J. McAuley of the Municipal Audit Department.

A customer of jovial disposition presented a large lighting account at the Local Office of the Hydro-Electric Power Commission, Belleville, Ontario, and made the statement that "the light was heavy," which would seem a paradox. However he was advised that the substance we sell you cannot see and you cannot see without the substance we sell. The customer murmured the well known fable of Napoleon "Able was I ere I saw Elba" and departed while he was yet able.



Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Hydro News Items

Central Ontario System

The new 4,400 volt line from Port Hope to Oshawa is now nearly completed and the section from Trenton to Port Hope is under construction.

* * * *

The new 4,400 volt station at Whitby will be constructed by the municipality in the early spring. The original plans for this station called for the installation of one 750 kv-a. transformer. Owing to the growth of load in Whitby it would seem that two 750 kv-a. transformers would be required immediately.

* * * *

The Gooderham & Worts' new radio station near Bowmanville will be ready for operation at the end of this month.

* * * *

An extension of three miles is now being added to the Port Hope Rural District.

* * * *

Niagara System

Arrangements are being made to supply 120 h.p. to a land drainage scheme in Tilbury East Township. New electric motor-driven pumps have been purchased and it is expected that they will be in operation the first week in February.

The equipment consists of 2 60 h.p., motors, direct-connected to 2 centrifugal pumps, each to deliver 15,000 gallons per minute against the maximum head of 9 ft. These replace 2 80 h.p. steam engines, belted to 2 vertical shaft propeller-type pumps.

This is the first application of Hydro power to the drainage of land used for agriculture where high-efficiency drainage pumps have been used.

The Commission is at present supplying 4 drainage schemes in the Wallaceburg Rural Power District where each motor is belted to a large dash wheel.

As there is a considerable acreage in the Lake St. Clair District, which is artificially drained, using steam engines as the mode of power, it is expected more of these steam plants will be replaced by Hydro in the future.

* * * *

A gravel company has signed a contract with the Commission for approximately 400 h.p., to operate a large gravel pit south of Waterford. The recovery of gravel is by means of an electrically operated suction dredge, together with auxiliary equipment for washing, grading and storage operations. They are expected to commence about May 1st, 1928.

* * * *

In accordance with a request for better lighting, the Seaforth Public Utilities Commission has erected orna-

mental brackets on the main street from the C.N.R. to Huron Street. Each unit consists of a cast iron bracket with 300 watt multiple lamps enclosed in acorn shaped globes. Good diffusion without glare and high efficiency are obtained by using globes of the rippled glass type.

* * * *

Walton Rural Power District has been extended by a three-phase line from Blyth to Auburn and a tap line serving Londesborough. Auburn first received power on December 9, 1927, and Londesborough on December 21, 1927. The district is served from Walton station, which was installed a few years ago to supply the Village of Blyth and the Town of Brussels.

* * * *

The St. Thomas Hydro-Electric Commission is taking steps to have the greater portion of the large commercial lighting consumers measured on energy demand meters. This is a step in the right direction, and the installation of demand meters usually results in a decreased bill to the consumer.

* * * *

The growing load in North York Township has made necessary the installation of additional 900 kw. in transformer capacity at York Mills substation.

* * * *

St. Lawrence System

Rural meetings have recently been held in the neighburhood of Brockville, where a marked interest was shown in rural service. Some 150 were present at a meeting held at Addison, and a second meeting was held at Maynard. Requests were received for the holding of further meetings in the district south of Smiths Falls, surrounding Jasper, Toledo and Easton.

* * * *

On the request of the village of Athens, an estimate is being prepared of the cost of building a distribution system in Athens.

List of Electrical Devices, Material and Fittings

Approved by the Hydro-Electric Power Commission of Ontario in December, 1927.

Appliances

BENJAMIN ELECTRIC MFG. CO. OF CANADA, LIMITED, 11-17 Charlotte St., Toronto.

6-volt Battery Charger.
"B" Power Unit.

BROWN & SHARPE MFG. CO., Providence, R.I.

Electric Hair Clippers.

* * * *

CANADIAN CHROMALOX COMPANY, LIMITED, 251 Queen St. E., Toronto.

"Chromalox."

Electric Air Heaters.

Electric Water Heater. Type AWH

* * * *

CANADIAN WESTINGHOUSE COMPANY, LIMITED, Hamilton, Ont.

Low Oven Apartment Range, two burner cooking top. Type H. S No. H21437.

* * * *

DETROIT ELECTRIC FURNACE COMPANY, 2231 Park Blvd., Detroit, Mich.

Electric Furnace. Types LF, LFA, AA, B, BB, C and CC.

* * * *

ELECTRO DENTAL MFG. CO., 33rd and Arch Sts., Philadelphia, Pa.

Electro Dental Junior Unit "G."

* * * *

THE HAPPY THOUGHT FOUNDRY COMPANY, LIMITED, Brantford, Ont.

"Happy Thought."

Electric cooking ranges. Cabinet series Nos. 5 and 194; low oven series, Nos. 4, 32 and 464.

Electric hotplate. Two-burner, Cat. No. 129.

Portable electric hotplate, Cat. No. 181.

"Sunfire" mantel grate, Cat. Nos. 25 and 30. Open hearth grate Cat. No. 22. Portable grate type heater, Cat. No. 20.

* * * *

THE ONTARIO EQUIPMENT CO. LTD. 354 Sparks Street, Ottawa.

Electrical equipment for oil burning furnace.

* * * *

PRICE AND HAWKE, 381 Wellington Street, London, Ont.

"P & H" stationary battery charge —garage type.

REGAL ELECTRIC MFG. COMPANY, 384 King Street, West, Toronto.

Electric Floor Polisher. "Regal."

* * * *

*BAUSCH & LOMB OPTICAL CO., Rochester, N.Y.

Stereoptican Type Picture Machine

Balopticons for the projection of stereoptican slides or reflected images. Types FRA, CRM, BM.

Automatic Balopticon for advertising purposes. Type AUI and AU3 automatic Balopticons.

* * * *

*BETTS & BETTS CORPORATION, 645 West 43rd St., New York, N.Y.

Motor-operated sign flasher machines.

"Wynk-A-Lyte" thermostatically operated, medium base flashers.

Edison plug type, 110-220 volts; 60 watts, Cat. No. 602; 100 watts, Cat. No. 603.

Surface type, 120 volts, 60 watts, Cat. No. 612; 100 watts, Cat. No. 613.

* * * *

*CINCINNATI VICTOR CO. THE, 712 Reading Rd., Cincinnati, Ohio.

Portable Electric Air Heaters. "Cincinnati."

* * * *

*CRAMBLET ENGINEERING CORP., 286-288 Milwaukee St., Milwaukee, Wis.

Thermostatically-operated sign flashers. Cat. Nos. A-10, B-10, C-10 D-10, A-12, B-12, C-12, D-12.

* * * *

*CROWE MANUFACTURING CORPORATION, THE, 225-229 E. Third St., Cincinnati, Ohio.

"Crowe." Portable electrically-driven circular wood saws. Models A-6, A-8, A-12.

Marking: "Crowe Safety Saw," name and address of manufacturer; rating.

* * * *

*GRISWOLD MFG. CO., THE, Erie Pa.

Electrically-heated waffle irons. Cat. No. 110-8-E.

* * * *

*O. K. MACHINE CO., INC., Fairfield Ave., and Poplar St., Fort Wayne Ind.

Portable motor-driven, suction cleaner. Model A.

* * * *

*METAL WARE CORPORATION, Two Rivers, Wis.

Electric Toy Ranges. Cat. Nos. B-25, B-26, B-27.

Steam engines. Cat. Nos. B-30, B-31, B-42.

Toy Steam turbine engine. Cat. No. B-35.

Toy hot air engine. Cat. No. B-38.

* * * *

*SPENCER LENS CO., 19 Doat St., Buffalo, N.Y.

Portable still picture projectors of the non-professional type "Delineascopes," hand operated, Models I, T.M.; motor-operated, Models L.

Switches

COPE AND SON, LTD., 150 Hastings St., W., Vancouver, B.C.

Service entrance switches, two-pole. Enclosed branch circuit cutouts.

Fittings

THE R-T MANUFACTURING COMPANY, 39 Yarmouth Street, Guelph, Ont.

Medium Base Sockets. Metal Shell Pull Chain. Keyless.

Marking: "RT" and the rating stamped in brass shell.

WEISS & BIHELLER INC., 69 Adelaide St., E., Toronto.

Medium Base Sockets, keyless, metal shell.

* * * *

*BENJAMIN ELECTRIC MFG. CO. 120-128 S. Sangamon St., Chicago, Ill.

Separable and non-separable porcelain or composition attachment plugs. Cat. Nos. 903, 903-A, 903-C, 903-E, 903-H, 904, 907, 907-B, 908, 916, 919, 938, 940, 945, 948, 960, 961, 962, 1001. "Convert-A-Cap." Cat. Nos. 937, 940, 946, 949, 1000.

Adapters, parallel blade to Edison. Cat. Nos. 1006-B and 1009.

Marking: "Benjamin" stamped or molded in devices.

Miscellaneous

*METEOR ELECTRIC CORPORATION, 499 East 70th Street, New York, N.Y.

Medium Base Sockets (As listed on Underwriters' Laboratories card dated September 30, 1927.)

* * * *

*BELDEN MFG. CO., (Submittor) 23rd St. and Western Ave., Chicago Ill.

Radio Lightning Arrester for indoor or outdoor use.

Marking: "Belden" with type designation "Non-Air-Gap" and wording "Radio Lightning Arrester."

* * * *

*PIERCE RENEWABLE FUSES, INC., 752-58 Main St., Buffalo, N.Y.

"Pierce." Renewable Plug Fuses.

* * * *

*COMMERCIAL ENCLOSED FUSE CO., 1317 Willow Ave., Hoboken, N.J.

Cartridge Enclosed Fuses—Non-renewable.

* These devices are under the Underwriters' Laboratories re-examination or label service.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Estimates of Power Capacities for Developments on the Mississagi River

IT is understood that the municipalities in Ontario have been circularized by a statement taken from the *Sault Daily Star* of January 23rd, 1928, which refers to the capacity of the Mississagi River developments.

With regard to the capacity of the Mississagi River; the 1925 report of the Ontario Department of Lands and Forests gives the minimum flow capacity as 32,013 and the six months' flow at 57,043 horsepower under ordinary conditions.

The flows referred to are the natural flows of the River, without any improvement of storage facilities for its regulation.

The estimate submitted to the municipality of Sault Ste Marie at 125,000 to 135,000 horsepower provides for storage facilities to properly regulate the river, and under such conditions the continuous horsepower can be increased to 94,234 horsepower, which, at 70 per cent. load factor would justify the installation of 134,600 horsepower, or approximately the maximum figure which was given to the electors at the Soo.

The following is a tabulation of the power sites on the Mississagi River, showing the head, the estimated flow and the horsepower that might reasonably be expected at the different sites on this river.

All data for the sites above Aubrey Falls was taken *in toto* from the report of the Ontario Government on Water Powers, published in 1925. From Aubrey Falls to the mouth, the concentrations used were those obtained from the reports and investigations of the Commission's en-

gineers in 1927. The run-off of .63 c.f.s., per square mile of drainage area was used in the determination of the flow, which is conservative for this area, having in mind the storage possibilities on the Mississagi River:

It is possible that from a more thorough investigation of the storage facilities of the river that the capacities of the plants under 70 per cent. load factor may be increased to 150,000 to 200,000 horsepower.

MISSISSAGI RIVER

Estimated Capacities of Power Sites

Site	Head	Estimated Flow	Continuous H.P. at 80 % Ef.	H.P. at 70% L.F.	
Rapids above Hell-gate Portage	0	154	280	400	
Hell-gate Portage	58	165	870	1,243	
Rapids below Hell-gate Portage	26	188	444	634	From Report of Ontario Government of 1925—List of Water Power in Ontario.
White Horse Rapids	18	388	634	906	
Rapids above Lake Minnisagun	15	411	560	800	
Mountain Portage Rapids	31	530	1,493	2,133	
Split Rock Falls	20	540	981	1,401	
Aubrey Falls	135	1,036	12,715	18,164	
Mashagama Portage	29	1,033	2,723	3,890	
Just below line between 2F and 3F	23	1,500	3,136	4,480	
Half mile above Gravel River	23	1,500	3,136	4,480	
One and a half miles below line between 1F and 2F	50	1,570	7,136	10,194	Flow based on run-off of .63 c.f.s. per square mile of drainage area.
About centre of 1F; Pig Pen chute	30	1,600	4,364	6,234	
Two miles below line between 188 & 1F	40	1,610	5,854	8,363	
Gros Cap, Con. VI, Haughton	35	1,690	5,377	7,681	
Squaw Chute	20	1,715	3,118	4,454	
The Tunnel	160	1,744	25,367	36,238	
Red Rock	78	2,263	16,047	22,925	
	811		94,235	134,620	

CONTENTS

Vol. XV **No. 2**

February, 1928

	Page
Estimates of Power Capacities for Developments on the Mississagi River	33
Some Factors Involved in Bulk Transmission of Power	36
Canadian Watthour Meter Practice	46
O.M.E.A. and A.M.E.U. Report	61
Hydro on the Farm	62
A.M.E.U. Reports	64
Grounding Devices and Equipment	77

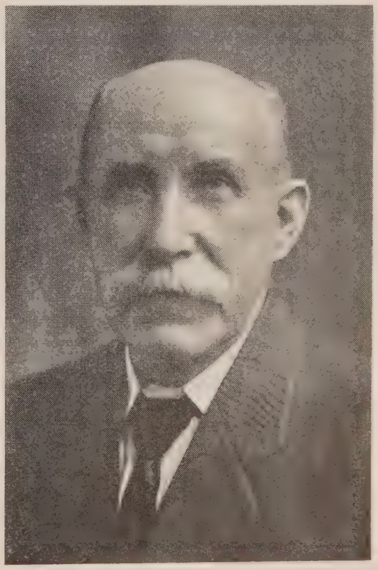
An Electrical Pioneer Dies

It is with regret we record the passing of Mr. Robert Elliott, Manager, Galt Public Utilities Commission, on Sunday, February 5, 1928.

Mr. Elliott was closely allied with the electric utility in Galt for nearly 42 years. It was in 1886 that the first electrical installation was made in Galt when a generator capable of delivering 75 horsepower was installed in an old mill and driven by an over-shot water-wheel. Mr. Elliott assisted in the installation of this plant and upon its completion became its Superintendent. In 1888 the original company sold its holdings to the Galt Gas Light Company for whom Mr. Elliott continued to act as Superintendent of both electricity and gas departments until the electrical utility was taken over by the municipality in 1910. After this change he continued as Electrical Superintendent for a few years, later being raised to the rank of Assistant Manager and finally to that of Manager, continuing as such until his death.

Mr. Elliott can, therefore, be considered one of the pioneers of the electrical industry in Ontario, and it is for this reason that he has been affectionately spoken of as the "Daddy of electrical industry in Galt."

Mr. Elliott had been seriously ill with heart trouble since early in November and his end was not unexpected. He was born in Galt in 1857 and although he never entered public life, he took a deep interest in all matters pertaining to the city's welfare. Surviving him are his wife, five sons, and ten grandchildren, to all of whom we extend our sincere sympathy.



Late Robert Elliott

Some Factors Involved in Bulk Transmission of Power

By G. D. Floyd, Assistant Laboratory Engineer, H.E.P.C. of Ontario.

(Read before the Association of Municipal Electrical Utilities at Toronto, January 18, 1928)

THE transmission of large blocks of power over longer distances and the accompanying increase in transmission voltage have dictated close attention to the electrical design and economic features of power transmission. By electrical design is meant the calculation of regulation, synchronous condenser capacity, power loss under load, stability of operation and short circuit kv-a. rather than the physical layout of line and towers, or the number and characteristics of insulators, clearances to towers or design features of that nature. The latter, while of the highest importance are of quite different nature.

This paper will deal with electrical design as defined above, and will discuss some of the economic features involved, having in mind the bearing which these have on the final selection of a suitable size of conductor in any given case. The points discussed apply more particularly to the transmission of large blocks of power over distances in excess of, say, 100 miles, although generally speaking, the length of line and the quantity of power to be transmitted only affect the quantities involved in magnitude. That is, to say, in the transmission of a small amount of power over a short distance, some factors can be neglected, which must be considered in the case of the long line carrying relatively large power per circuit.

In any given case, methods of analysis may follow different courses as to detail, but they all aim to arrive at the same thing, namely, the determination of the most economic layout to transmit and deliver the power with a satisfactory degree of security.

Assume a large block of power to be transmitted over some distance. A general survey of the problem would indicate that choice has first to be made from among several fundamental alternatives.

(1) *Choice of Frequency*

It so happens in practically every case that the transmission of power in large blocks has as its object the supply of additional power to a system already existing, or to serve a field where a standard frequency has already been adopted. In any case, the number of frequencies for which standard equipment is available is limited to two or three, hence choice of frequency is settled by expediency rather than on its technical merits. One or other of the standard frequencies might be deliberately chosen,

different from the one already existing in the district to be served, and frequency changers installed at the receiving end, but the additional cost would have to be justified by some saving effected directly by frequency and it is often difficult to show this.

(2) *Choice of Voltage*

Choice of voltage is a matter of expediency, also in a great number of cases, but to a lesser extent than choice of frequency. In the first place, voltages have been standarized, so that if standard equipment is to be used to the best advantage, one of the standard voltages should be used. If interconnection is contemplated with another system, adoption of equal transmission voltage for both will obviate the necessity of transformation at the point of interconnection.

Someone has stated a rough and ready empirical rule to be "one kilovolt per mile of transmission distance." Of course, there are any number of exceptions to this rule, but it can be used as a first approximation in numbers of cases. If the importance of the transmission justifies it, the choice of voltages can be narrowed down to two or three, and a detailed analysis made of these, selecting the most satisfactory on the basis of this study.

(3) *Choice of Conductor Size*

The choice of conductor is governed by economic considerations once the voltage has been chosen, a lower limit to the diameter of conductor being set by the fact that for any given diameter of wire there is a voltage at which corona will appear on the wire. Therefore, unless the loss which accompanies corona is accepted, the smallest diameter of wire that can be used is fixed once the voltage is fixed. The above assumes that conductor of the usual stranding is used. Recently a special stranding has been placed on the market in which the effective diameter of the conductor has been materially increased by forming the conductor with a hollow core, in which is a twisted strand having I beam cross section.

Mechanical design fixes an upper limit because as the cross section, and therefore weight per foot, are increased, the towers and conductor support must also be increased. Sooner or later, it is found that it becomes more economical to use two circuits with total cross section equal to that of the single conductor. Better service security can be given with a number of parallel circuits than with only a single circuit, hence this consideration will often determine the maximum diameter of conductor, before considerations of mechanical design dictate division into multiple circuits.

It is therefore unnecessary to make a detailed study of a large variety of conductors, as the choice can be narrowed down by a first approximation to three or four.

The problem then resolves itself into a calculation of the electrical characteristics for the two or more system voltages to be considered, and for a selected number of conductor sizes and circuits. With this information available, tentative designs can be made, and approximate unit costs of stations compiled. The

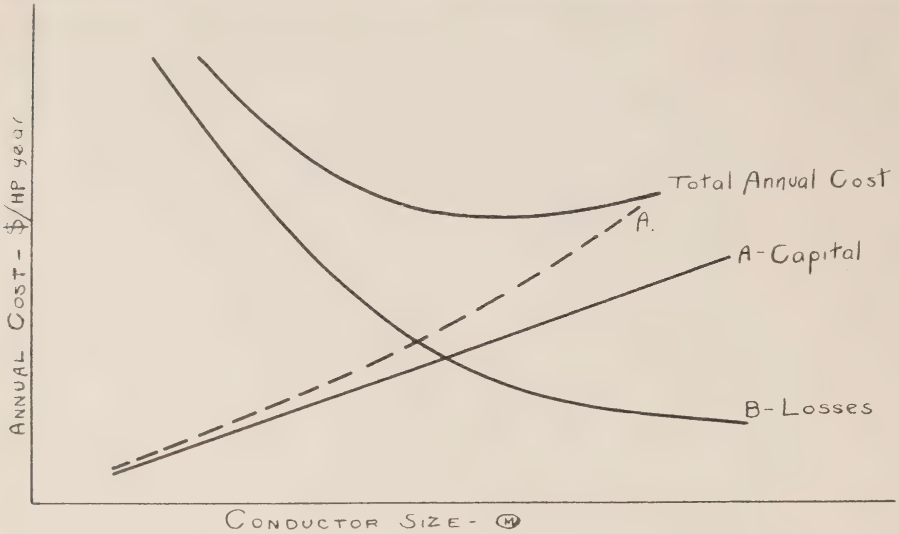


Fig. 1

next step is to obtain the cost of all items entering into the transmission for the various arrangements selected, from which, one giving the least annual cost can be found. If this arrangement is not objectionable for some other reason it should be adopted. Some of the factors which dictate adoption of an arrangement other than the most economic will be discussed later.

A detailed discussion of the methods used to determine the line losses, voltage regulation, synchronous condenser capacity required, and other electrical characteristics is outside the scope of this paper. A number of methods are available, and any one of these giving the degree of accuracy required can be used.

Economics of Design.

Quite wide latitude could be allowed in the choice of conductors and number of circuits if the economic feature were neglected. A size of conductor could be decided upon arbitrarily, and the mechanical design, voltage regulation and absence of corona might give complete satisfaction. Analysis of costs might show, however, (1) that due to the large capital expenditure in a conductor of large cross-section or (2) since the losses were extreme because not enough money was spent in conductor as a result, the total annual cost was higher than it might have been, even assuming that all other considerations had been met.

Lord Kelvin first stated the economic law governing the relation between size of conductor and annual transmission cost. Stated briefly, it is that the minimum total cost of transmission will obtain when the annual cost of the money invested in the conductor equals the value of the power lost in the conductor. That is to say, if a curve is plotted, as in

Fig. 1, showing the annual cost of the conductor in $/H.P. year, and another showing the cost of the losses with conductor cross-section as abscissae, the point of intersection is the point of minimum total cost, and the conductor corresponding to this point will be the most economic for the conditions assumed.

Practically, it is not correct to take the cost of the conductor alone. There are several items of cost which vary with the size of conductor. The first, and most obvious, is the conductor support. When synchronous condensers are used, the kv-a. of these varies to some extent with the size of conductor, and to a greater extent with the number of circuits. If these costs be included, a new curve A_1 Fig. 1 is found for the annual cost of capital, and a new point of intersection with the loss curve.

While a first approximation of the conductor size may be made neglecting some of the variables and taking cost of conductor alone, the better plan is to include all of the capital

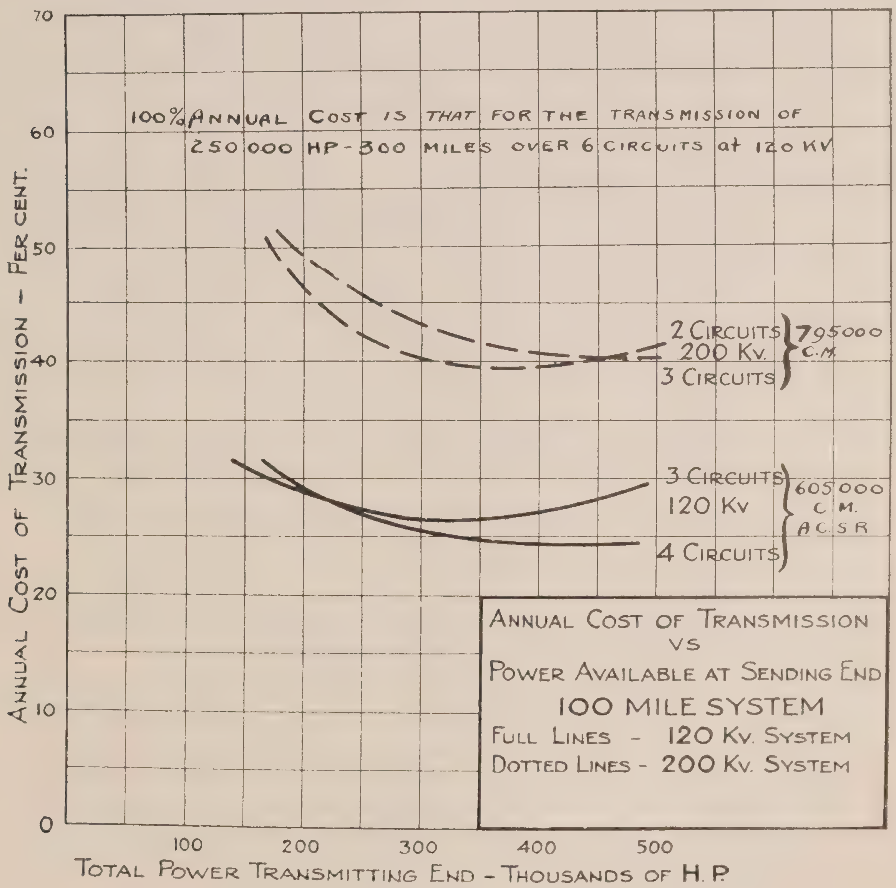


Fig. 2

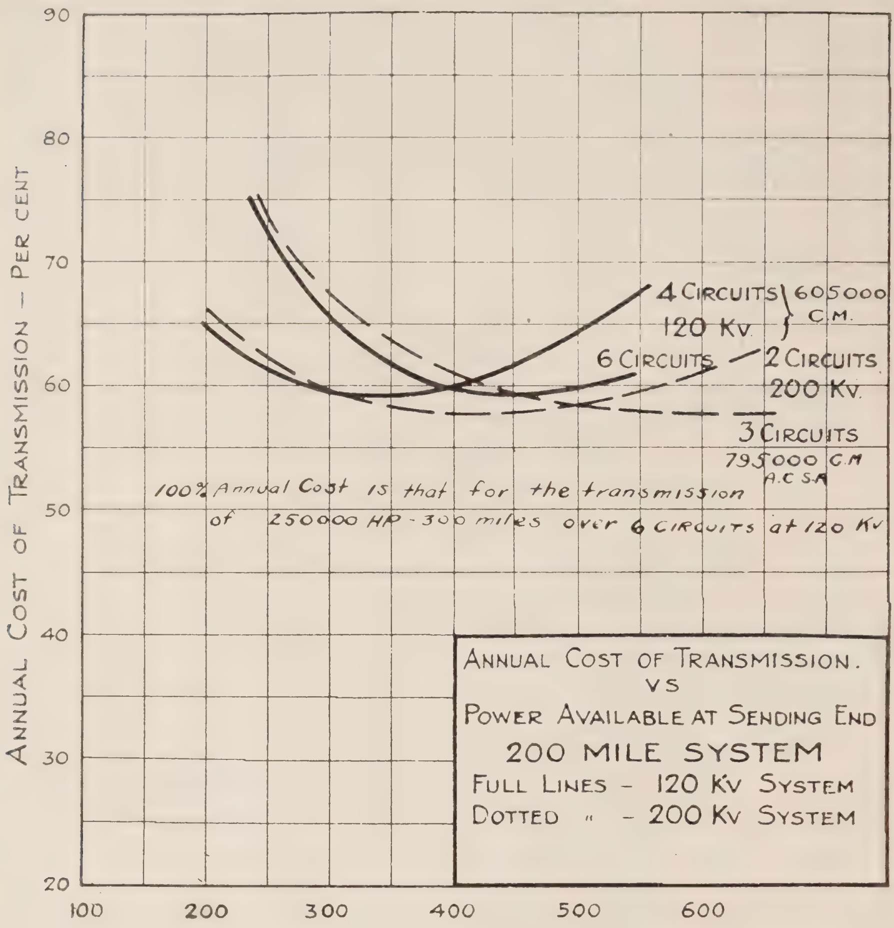


Fig. 3

cost entering into the transmission, determine the annual cost, and add to it the cost of the losses. If the total cost is plotted, in a similar way to Fig. 1, the point of least annual cost will be shown, and the economic size of conductor found. By this method, there is the added advantage that the calculation at once shows the annual cost of transmission, and itemizes the component parts, giving information which is valuable for other purposes.

A general study of the economy or otherwise of transmitting various amounts of power can be made in a manner similar to that outlined above. In this case, a set of calculations must be made at several values of power transmitted, for each circuit condition and size of conductor.

Figures 2, 3 and 4 show typical sets

of curves for an economic study of the annual cost of transmitting various blocks of power at 120 kv. and 200 kv. over selected numbers of circuits. The transmission distances considered were 100, 200 and 300 miles. These curves are only intended to show a typical case, and cannot be applied generally. This will be apparent at once when it is realized that an annual cost is made up of factors that vary over a wide range, enough in many cases to make the curves appear in an altogether different relation, both among those in one group, and between groups themselves.

For the particular system shown in the above three cases, it is apparent that for a transmission distance of 100 miles, it is always more expensive to transmit at 200 kv. than at 120 kv. If transmission is undertaken at 120 kv., it will be cheaper to install a fourth circuit when the load is in excess of 200,000 h.p. total or 66,000 h.p. per circuit, based on the original number of circuits.

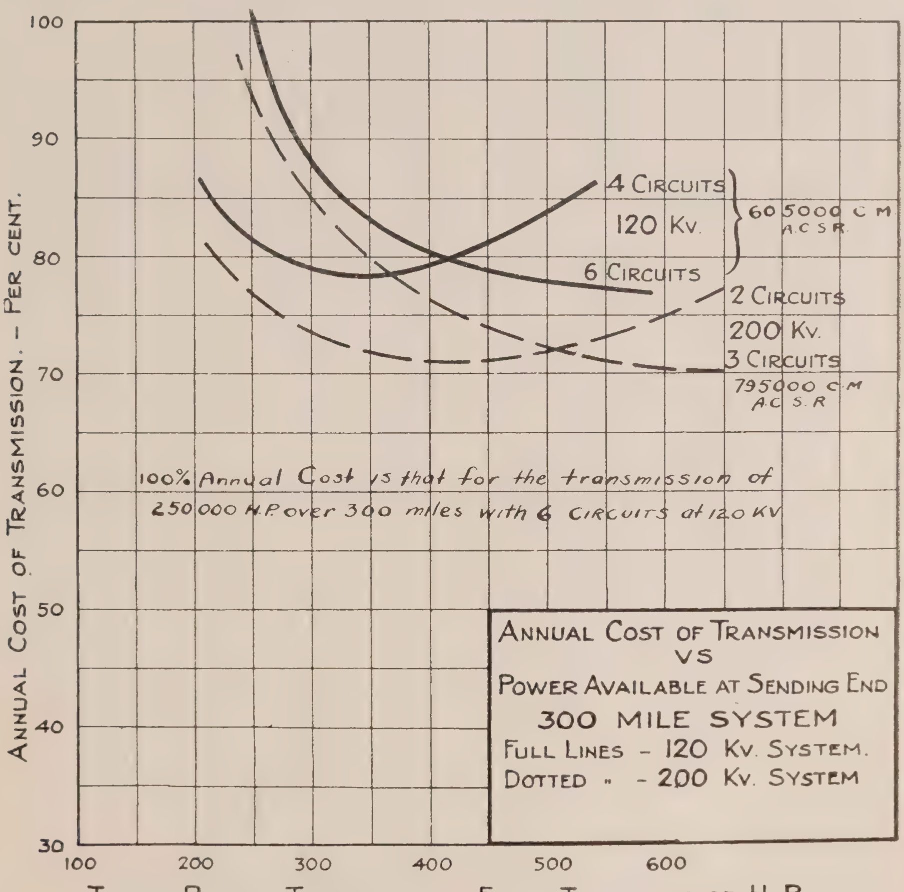


Fig. 4

The 200 mile system shows very little difference in annual costs between the two voltages studied up to loads of 300,000 h.p. total. Above that load there is a fractional advantage for the higher voltage.

The 300 mile system shows a considerable saving if operation at the higher voltage is undertaken.

Cost of Power Loss.

There is always a question as to how the cost of power loss should be estimated. Any particular case should be analyzed very carefully before assigning a value, which may be found later to be in error.

Some of the factors bearing on this point may be briefly analyzed.

(1) *Where all the power cannot be sold*

In this case it seems hardly fair to charge anything more to the account of transmission losses than the actual cost of generation, or if the power is purchased, the cost to the purchaser, at the point of purchase. A different value might be assigned depending on whether the power was steam generated or hydraulic. In the former, the fuel cost, which varies with the load, is a major factor in cost. In the latter case, the capital cost is practically the total, and as long as generating capacity is available, it might as well be used supplying losses, thus keeping down the total cost to the consumer by using a smaller cross-section of conductor.

Obviously, the growth of load in reference to the station capacity and the life of the line must be estimated, for while a smaller conductor might be satisfactory for the first few years of operation, the natural growth might be quick enough to justify a larger one, if the whole life of the line be considered.

(2) *Where all the power can be sold*

It is a rather nice point to decide what figure to use in this case. If no further power could be developed, or was available, the selling price of the power at point of delivery, would seem to be the logical figure to use. If power could be developed, the cost of generation for the next plant might be taken. This plant might be hydraulic or steam, and if the latter, the question of load factor would have to be considered, as the cost of generation in a steam plant depends very greatly on the load factor of the plant.

(3) *Load Factor*

As far as the cost of the losses is concerned, load factor is considered only where the power is disposed of on a kilowatt-hour rate, or is purchased on that basis. If there is interconnection with another system, the latter disposing of off-peak power, then the economy of the system as a whole will be determined to a greater or less extent by the amount of energy available for secondary power. No rule can be laid down in cases like this regarding the value of the losses. Each case should be considered on its merits, and a fair value arrived at after all factors influencing the cost have been considered, and given due weight.

The final selection of operating voltage, conductor and number of circuits cannot always be made solely from an inspection of curves similar to the ones just discussed. Even if the number of variables from which choice can be made has been narrowed

down before the calculations were made, the final decision must be made subject to a number of limitations. Some of these have been mentioned previously, for example, the limitation due to formation of corona, and that imposed by mechanical design.

There are other limitations which influence the final selection of conductor and number of circuits, and involve the final decision as to system voltage.

(*a*) *Security of Service*

Where large blocks are to be transmitted, it is practically essential that the service be continuous, therefore any design which cannot guarantee this, should not receive consideration solely because it happens to be the most economical. Economic studies might indicate that a block of, say, 300,000 h.p. could be transmitted more cheaply over one circuit of 800,000 cir. mils conductor at 220 kv. than over three circuits of 600,000 cir. mils., at 110 kv. However, it would be practically impossible to guarantee continuous service with the more economic arrangement, and this arrangement, consequently would not be adopted.

The question of security of service versus most economic number of circuits appears to be one that will always be raised when transmission voltages of the order of 220 kv. are contemplated. The large block of power at 110 kv. usually requires a number of circuits for economic reasons which will guarantee continuity of service. That is, to say, the reduction in losses by providing extra circuits may more than compensate for the annual charges on the cost of the extra 110 kv. circuits.

Service security may be obtained, however, in other ways than by providing a multiplicity of circuits, for blocks of power usually available in one locality. Methods that suggest themselves are.

(1) Building a line of the very best type mechanically and electrically, and providing adequate maintenance, the idea being to reduce line outages to the least possible number.
(2) Providing interswitching stations, in the case of long lines without intermediate stepdown stations. These interswitching stations, if equipped with oil circuit breakers, would clear a section of line in trouble, leaving the remainder in service. There must be a minimum of two circuits if the above arrangement is contemplated.
(3) Using a line relay protective scheme which would clear faulty lines quickly, limiting the damage to the line, so that it could go back into service with the least possible delay.

(*b*) *Limitations due to short circuit kv-a.*

This is perhaps more dependent on the amount of power that may be concentrated on a system than on the number of circuits. The short circuit kv-a. that a circuit breaker can handle without damage is limited, hence, any layout that is proposed must keep this limitation in mind. Circuit breakers are being built with ever increasing rupturing capacity,

but systems are growing larger to the same or even greater degree, and the system must be designed with this limitation always in mind, and the short circuit kv-a. on any particular circuit breaker restricted to not more than the estimated capacity of that circuit breaker.

(c) *Limitation due to Line Instability*

There is a very definite upper limit to the amount of power that can be transmitted over a circuit of given impedance. Therefore, before a final decision is made as to the size of conductor and number of circuits to be used to transmit a given amount of power, calculation should be made to determine whether the specified amount of power can be transmitted.

Briefly stated, transmission of power over an alternating current circuit containing impedance is accompanied by a displacement in phase between the voltage at generating and receiving ends. This phase angle increases with load until at an angle of approximately 90° between the two voltages, the maximum power transfer occurs. If an attempt is made to increase the power transfer the synchronous equipment at either end of the line drop out of step. The phenomenon is exactly similar to the limit of power output, or its equivalent, the pull-out torque of a synchronous motor.

In a number of cases, this problem hasoccurred without being recognized. It is not limited to long lines at high voltage, although more likely to occur under those conditions, because the economic load per circuit may be higher, and because the increased length of line, and increased separation of conductors both cause an increase in the impedance between generator and load. Hence, if the loading per circuit is suspected of approaching the maximum power limit, a further study of this possibility should be made, and means provided, if considered necessary, to improve conditions.

Summary

An attempt has been made to indicate in a general way how the problem of transmitting a block of power may be analyzed, and the information necessary for an analysis of the same indicated.

The factors influencing choice of conductor and number of circuits to give most economic operation have been discussed, and some of the limitations affecting the final choice have been pointed out.

Naturally, each system must be studied on its merits, and no general conclusions can be drawn from a study of an isolated case. This point cannot be too strongly emphasized. There are so many factors affecting the final decision on any one point that it is quite impossible to make a reasonable guess at what should be done, unless a study is made of the proposed system. Even with the data made available by calculation, it is still very often a matter of good judgment to make a final selection of the best layout.

Discussion

Mr. G. D. Floyd: In the first place I want to say that the features covered by the paper do not cover everything that has to do with the Bulk Transmission of power. I have undertaken to write or set out some of the factors involved in the electrical design; and by electrical design, I mean design features such as the calculation of regulation, the condenser capacity required, and other features of that nature. I did not intend to touch the mechanical features or anything of that nature. The two have very little bearing one on the other, and the latter would require a paper in itself.

In the second place, the paper really deals with the bulk transmission of power; that is, the transmission of relatively large blocks of power; from a lower limit of 100,000 h.p., and from there up as high as the transmission of power goes.

Mr. E. V. Buchanan, London: In speaking of the total annual cost, the writer simply mentions the capital charges, I believe, on the cost of the conductor and its supports. Wouldn't the annual maintenance cost have to come in that calculation, to get the proper equation between the cost of the transmission line and the cost of the losses? When an engineer makes his calculations, works them out to great refinement and gets his answer, how long does this designed transmission line remain the most economical line? In dealing with problems of distribution, I find that one day we think that we have an economical distribution system, but a month or so later it is all wrong because of the rapid growth of the load.

Mr. Floyd: The line A., which is called Capital is not the money that we have invested in the line, but the annual cost of the money. The maintenance charge is one item in that total percentage. The second point was, how long is a transmission line an economic line? If you figure out the economic line for a given block of power, it is only economical as long as you are transmitting that block of power. If your load increases, you are not operating at the economic point any longer. If you refer to Figure 4, these curves show the annual cost for different amounts of power at the transmitting end. You will note that we have taken four circuits at 120 kv. The cost starts at 200,000 h.p., at about 86 per cent. and gradually decreases as the power is increased, till at about 300,000 h.p., the cost was about 78 per cent. You will note that, for a considerable amount of power, either side of that most economic power curve, it is relatively flat, so that you will be operating practically as an economic line for a given value of power on either side. But if it was increased greatly, you will come to a point–at a little over 400,000 h.p. —where it will be just as cheap to put in six circuits, and, theoretically speaking at that point two extra circuits should be put in, and the annual cost would be the same.

Canadian Watthour Meter Practice

By Joseph Showalter, Canadian Westinghouse Company, Limited, Toronto

(Read before Association of Municipal Electrical Utilities at Toronto, January 19, 1928)

THIS subject would indicate that meter practice is different in Canada than elsewhere. This is true.

Government Inspection

We have in Canada, authorized by the "British North America Act" and operated under the Department of Trades and Commerce, a system of Government Control over all our watt-hour meters.

Every make or type of meter sold in Canada must have the approval of the Gas and Electricity Inspection Department at Ottawa. To obtain this the manufacturer must send a sample meter to Ottawa along with complete specifications and drawings. If the department, after many tests is satisfied, a bulletin is issued authorizing its use.

Each meter used on a customer's load must be a duplicate of a meter approved at Ottawa, and must be tested and sealed by an inspector of the Gas and Electricity Inspection Department.

The official looking red wax seal covering the ends of wires threaded through the cover nuts and studs is completely effective in preventing access to the interior of the meters.

If it is necessary for any reason to break the seal wires to make adjustment or repairs to the mechanism of the meter it must be again submitted to a Government meter inspector for test and seal.

The seal bears a date, the year and the month. The Inspection Department keeps a record of all meters tested, with system serial numbers, which they mark on them. After five years service, during the sixth year they must be brought in and retested and if approved resealed, by an authorized inspector of the Dominion Government.

Any meter failing to test within the limits of the Department is rejected and must be adjusted by the meter man of the local system until it is within the required limits according to the Inspector's Standard meter.

The limits provided are 3 per cent. fast or slow, tests to be taken on a small load and a larger load. This tolerance would seem rather liberal. The fact is that most Inspectors work closer and try to keep all meters they verify within at least 2 per cent. on small and large loads, but make use of the extreme tolerance to pass an occassional meter that cannot be adjusted any closer on both light and heavy loads.

The Government Inspector makes no adjustments. His instructions are to make tests only, and to make a record and charge a fee for each test, whether the meter is approved or rejected.

Meter Sizes

Another reason why Canadian Meter Practice differs from that elsewhere, is that electricity is cheap here. More of it is used and we require larger meters. The smallest size of single phase meter supplied is 10 amperes. In Ontario more 25 ampere three wire meters are sold than of any other size.

We have very little direct current, so the only meters manufactured in Canada are induction meters for alternating current.

Meter design has become quite standardized by the Canadian Manufacturers, this makes for convenience and efficiency in Canadian Meter Practice.

Our meter practice is becoming standardized but is not being given the serious attention by a great many Public Electric Utility Systems, that it should receive.

The Meter Man

Every Public Electric Utility System should have a competent meterman. If the system is so small that there is only a manager and one or two assistants the manager should be qualified as the meterman.

As an alternative a number of Systems might employ a meter man in common.

In a small system the meter man can maintain and test all meters, install them on the customer's premises and make the readings for billing. He becomes acquainted with each installation and customer. He is often the only representative of the Public Utility System that the customer ever sees.

In a larger system he may have assistants but all work associated with meters comes under his supervision, except in some of the larger systems where the accounting department is responsible for the reading of meters.

Meter Department

A meter man will need a meter department. The meter department should centre in a definite place set apart for the purpose ; a light dry clean room or corner where a suitable test rack, work bench and storage places for meters are located.

The equipment is not costly. The most important is the test standard wattmeter, or watthour meter. The latter, commonly known as a rotating standard, is almost universally used. This is a very convenient and reliable instrument and is provided with multiple coil winding and switch or links to alter the rating from that suitable for small size meters to that needed for large meters. Several of the meter manufacturers supply these rotating standards.

Various designs of test boards are found in different meter departments. They range from a simple circuit with a group of lamps arranged on the wall, to elaborate sets, factory made with phase shifting devices and other features. Almost every meter man has his own idea as to the arrangement of a test board, but all test boards constitute a means of connecting the meter to be tested quickly, into a circuit in series with a test standard and load. There is usually a two or three pole switch at the source of current, flexible leads for

connecting to the meter, a place to hang the meter and a place for the standard, and several switches to vary the load. There is usually a creep switch, also, which disconnects the load but leaves potential on the meter.

The Government Inspection Department requires in addition a dial test rack. This is a board placed usually on the wall where a dozen meters or so can be connected in series on a load to be operated several minutes so as to verify the dial reading.

A reasonably large work bench is the only other important piece of equipment in the meter department. This is needed for any repairs or cleaning. A large size is needed when numbers of meters are being inspected and sealed. Here they are placed in rows after being tested, wired up and the wax applied. When a quantity of new meters are being handled or old meters are in for re-inspection, quite a bit of bench space is needed.

Some small tools, jewellers' oil, pith, crocus cloth, benzine, some bearing jewels, and pivots and perhaps a few other replaceable meter parts complete the essentials of a meter department.

Meter Application

Canadian Meter application is fairly well standardized. The ten ampere two wire meter is used in all ordinary residences where the load consists of lights and socket plug appliances. All ordinary homes with lights and range and perhaps a water heater are metered with the twenty-five ampere, two hundred and twenty volt, three wire meter. Some fifty ampere, three wire meters are used in the larger residences where there may be a number of electric heaters and perhaps two or more bath rooms with electric water heaters.

It must be remembered that our Canadian meters have a generous over-load capacity for both endurance and accuracy. The size of the meter applied to any residence service need not be any greater than one-third of the rating of the total connected load. On this basis it is unlikely that the meter will be required to carry much more than double load at any time because of the diversity, and greater accuracy will be obtained at low loads, which are carried for long hours in late night and the daytime.

Commercial lighting loads average nearly 100 per cent. the connected load value should be metered at not less than 50 per cent. of the value of the connected load.

Three phase power services, where energy is supplied for a single motor or several motors operating constantly, should be metered at more nearly the full value of the total motor rating.

The following formula will give the current values in each wire of a three phase, three wire system when operating a fully loaded motor or group of motors.

$$\text{Current per wire} = \frac{\text{Horse Power} \times .746}{1.73 \times \text{volts} \times \text{Power Factor} \times \text{Efficiency}}$$

In general three phase meters can be applied to motor loads as shown in the following table.

220 volts

5 ampere meter	2 h.p.
10 ampere meter	5 h.p.
25 ampere meter	7½ h.p.
	10 h.p.
50 ampere meter	15 h.p.
	20 h.p.
	25 h.p.
100 ampere meter	30 h.p.
	40 h.p.
	50 h.p.

550 volts

5 ampere meter	5 h.p.
10 ampere meter	7½ h.p.
	10 h.p.
25 ampere meter	15 h.p.
	20 h.p.
	25 h.p.
50 ampere meter	30 h.p.
	40 h.p.
	50 h.p.
100 ampere meter	75 h.p.
	100 h.p.

On large loads, either single phase or polyphase, it is becoming standard practice to use a 5 ampere meter with dial register geared as a 5 ampere meter, and multiply the readings by the ratio of the transformers used when current transformers are used, and the multiple of the ratios of the current and potential transformers where both are used.

Installation

It is obviously necessary to place the meter where the customer has his meter board. Wiring contractors are more considerate now-a-days when they arrange this meter board. But it would seem that the Public Utility men should determine more than they do, the location of the meter, considering the convenience of installation, the possibility of moisture, fumes or vibration damaging the meter, and the accessibility for reading.

Wherever the meter is installed it should be on a solid dry wall about level with a man's eye and where a man can walk right up to it with no boxes or furniture on the floor below the meter.

It is very important that single phase two wire meters be connected to the service so that the grounded neutral does not lead to the series coil terminals. The neutral might be purposely or accidently grounded beyond the meter and some of the current would shunt past the meter through the two grounds.

The terminal of the service and load wires should be carefully cleaned back about an inch or just far enough so that the shoulder of insulation will just go inside the terminal bushings. Careful cleaning of the wires is very important. Meters are sometimes burned out at the terminals due to a bit of insulation left on the wire making the contact imperfect. If the wires are stranded the ends should be dipped in melted solder.

Some Public Utility systems send a man to carefully inspect each meter installation a week or more after it is made to make sure it is right, the connections perfect and the meters functioning properly.

Single phase, three wire meters have a single shunt coil connected across the outside wires. It is possible to have one fuse blown ahead of the meter and the customer still have service on the other side, or he may obtain service on both sides by joining

the outside wires, but the meter will not operate.

This unsatisfactory condition is tolerated but the manufacturers are providing when required single phase, three wire meters with two separate terminals for the potential coil, so it may be connected ahead of the fuses in the service box. When the service box is effectively sealed this would seem a solution. But it appears that the customer can not be persuaded to honor the seal of the service box which is his own property.

Meter Reading

The dial reading is the ultimate purpose of this whole enterprise.

The meter reader maybe a man from this meter department or he may be from the accounting department, but he is tactful, courteous, clean and neat in appearance, thoughtful and considerate of the homes, offices and premises of the customers where he enters. He uses a flashlight, never matches, to see the meter dial. He does not smoke while on duty in any customer's home or other building.

The standard meter dial has no markings other than the figures around the four circles. The reading is a number made up of the figures represented by the pointers in the four circles. In meters up to about ten kilowatts capacity this number represents the total value in kilowatt-hours. In large self contained meters the word "Multiply by 10" or maybe "Multiply by 100" appears on the dial face. There is no uncertainty in the value of the dial reading.

Meter readers become quite expert, but some if not all occasionally make erroneous readings, nearly always too high.

The correct method of reading is from right to left, first units, then tens, hundreds and thousands. In this way he is sure of the value of any pointer that may be right on a figure, because he knows whether the figure to the right is just approaching or past zero.

It is sometimes desirable to observe just what the customers actual load is in kilowatts at any time. This can be read from the meter as accurately as the dial reading in kilowatt hours, but it is read from the disc. Count the revolutions for a period of one to two minutes using a watch. The kilowatts will be as follows :

$$\text{Kilowatts} = \frac{\text{Revs. of disc} \times K \times 3.6}{\text{seconds}}$$

The value K is the test constant or kilowatt hours registered by each revolution of the disc. It is marked on the nameplate of all meters of the present standard.

Maintenance.

One of the principal functions of the meter department is meter maintance. The meter man checks new meters received from the manufacturer, submits them to the Government Inspector and then they are installed on the customers' services. But when they have operated for five or six years and have been brought in for reinspection as required by the Government Department they are certainly entitled to a little cleaning up.

Meters have a tendency to become

slow due to dirt or congealed oil and sometimes roughened jewels.

Meters brought in for reinspection and found slow should never be adjusted until they have been cleaned. Almost invariably when the slow meter is cleaned it is found to be accurate within close limits unless it has a rough jewel.

The experienced meter man has a systematical procedure with meters brought in from service for reverification. It is very much as follows :

(1) He makes the "as received" test entering the result on his record card along with the dial reading and any other information as to its condition. The record of the test will be considered in subsequent operations.

(2) The seal wires are removed and the sealing wax chipped out of the seal cup.

(3) The exterior of the meter is thoroughly cleaned. Most meters will merely require being wiped of dust, others will need a wet cloth and a real washing. Some may be rusty and need repainting.

(4) The cover is removed and the glass cleaned. Alcohol and a clean cloth is useful.

(5) The meter with cover removed is held face down and shaken so any particles of loose material will fall out.

(6) The meter is hung in a vertical position and carefully inspected visually with a good light for rust, corrosion, mildewed insulation or filings at magnet poles. Any rust, corrosion or mildewed parts are cleaned and any filings removed.

(7) The test record is consulted. Most meters that have operated in a clean dry location will be found to be in very good condition and will need very little attention. The jewel in such meters, with the pivot jewel type of lower bearing, is removed, cleaned with pith and a trace of watch oil applied. The experienced meter man is very careful not to use too much oil. The jewels of the ball double jewel type are not oiled and in accurate meters will not require cleaning.

If the test shows the meter to be slow with a greater error on low than larger loads the meter man looks for excessive friction. He removes the jewel and examines it for roughness. If it is rough he replaces it with a new jewel cleaned and oiled after renewing the pivot also. If the friction persists, which can be noted by turning the disc slightly with the finger and noting how it slows down and stops, he removes and cleans the top bearing. Then he removes the register examining it for friction, if there is congealed oil in any of the bearings they will be found to be tight and are cleaned with benzine. Some registers require a touch of oil on the faster moving bearings, but metermen are using as little oil as possible and refraining from oiling at all where the friction is so

slight that it has no effect on the meter.

(8) If friction has disappeared and the meter seems all right in every way it is placed on the test rack and the connections made.

(9) The meshing of the first gear with the disc spindle worm or gear is carefully examined and if not just right corrected. It should be free but not free enough to disengage. The correct mesh of the teeth is slightly more than one half the depth.

(10) The meter is tested for creeping with potential only applied. If the disc turns under potential it is brought to balance by means of the light load adjustment. The point should be just under creeping forward. If excessive creeping occurs it indicates a short circuit in the series or shunt winding or damaged light load adjustment.

(11) The meter is tested at a load near full load and if necessary adjusted.

(12) The meter is then tested on about 1/10 load and if necessary adjusted.

(13) Final adjustments having been made on both loads, all adjustment locking screws or nuts are checked to see if they are tight and a final test is taken of both small and large load and the results entered on the meter record "as left".

(14) Polyphase meters should be tested on each element at 50 per cent. power factor. This is accomplished by placing a variable inductance in series with the load, or by means of a phase shifting transformer. It is well to test single phase meters on less than 100 per cent. power factor when major repairs have been made such as changing shunt coil.

(15) The meter is removed from the test rack, cover replaced, cover nuts screwed in place and seal wires fixed ready for sealing. The meter is ready for Government reverification. Some leave the seal wires off until after the Government Inspection test.

Ocassionally meters will need repairs such as fitting a new shunt or series coil. With most up-to-date meters this is quite a simple undertaking. In some of the older meters it will require more time and care. Where a meter has been taken apart for any reason great care must be exercised in connecting the coils to the terminal post to have the connections tight, making good electrical contact. An imperfect contact will develop heat and ruin the terminal and series coil.

Testing

Meter testing is a simple operation and could be accomplished by any Public Utility System electrician.

The meter dial shows the total amount of electric energy that has passed through it, in kilowatt hours. It is geared at a definite ratio from the disc spindle. In the earlier types of meters the registers of all sizes were geared alike. This made it necessary to multiply the reading by a dial constant which varied with the capa-

city of the meter. However present day meters read direct while the register ratio varies with the capacity of the meter, and the value in kilowatt hours of each disc revolution. This value is known as the test constant and is usually designated K. It appears on the nameplate or elsewhere on every meter.

A complete meter test consists of two operations, checking the value of the watthours per revolution of the disc and checking the ratio of the register.

If a meter is operated on a constant load for one hour the dial should show the same value in kilowatt hours as the load in kilowatts.

But *tempus fugit* and the meter man works in seconds.

The wattmeter stop watch method which prevailed before the days of the "Rotating Standard" and is still used for very close tests, made use of an indicating wattmeter which measured the load, kept constant for a period 30 to 120 seconds while the revolutions of the disc are counted and timed by a stop watch. Then reference is made to the following formula :

$$\text{Seconds} = \frac{\text{K} \times \text{revolutions} \times 3600}{\text{watts}}$$

"K" represents the watthour constant of the disc, 3600 is the number of seconds in an hour.

If the stop watch showed too many seconds the meter tested slow. If too few the meter tested fast. The per cent. accuracy is :

$$\frac{\text{Correct seconds}}{\text{Seconds obtained in test.}}$$

The standard watthour meter or rotating standard method has become almost universal because of its convenience and independence of voltage variation.

This method consists in merely operating the meter in series with the rotating standard and comparing the watthours registered by each. This is accomplished by operating the meter and standard on the same load for the same time while the revolutions of the meter disc are counted and the revolutions of the standard read on its dial. The result is as follows :

$$\frac{\text{Meter revs.} \times \text{its constant}}{\text{St'd revs.} \times \text{st'd constant}}$$
$= \text{accuracy}$

In practice a number of revolutions of the meter under test are counted the standard potential circuit being closed at the beginning of the first revolution and opened when the spot passes at the end of the count.

The number of revolutions counted on the meter is multiplied by its constant, and divided by the standard constant. This gives the number of revolutions which should show on the standard dial.

$$\frac{\text{revs. of meter} \times \text{meter constant}}{\text{standard constant}}$$
$= \text{revolutions of standard}$

For example, testing a 10 ampere 110 volt meter having a constant of 0.6 with a rotating standard having a constant of 2/3.

$$\frac{20 \times 0.6}{2/3} = 18$$

The meter should be counted 20 revolutions while the standard shows 18 revolutions, or 1 revolution while the standard shows 9/10 revolution.

When testing three wire single phase meters on one side it is necessary to double the meter constant.

A meter man using a rotating standard soon learns the relative speeds of different meters and has little occasion to calculate his test ratios.

The dial test is usually accomplished by connecting one or a series of meters on a load of one or more kilowatts and operating for six minutes, (1/10 of an hour). The test dial should register 1/10 kilowatt hour for each kilowatt of the load. That is if its load was 1 kilowatt the test dial at the end of six minutes should read 1/10 kilowatt hour, or 3/10 kilowatt hour on a three kilowatt load.

$$\text{Dial Reading in Kilowatt Hours} = \frac{\text{Watts} \times \text{Minutes.}}{60{,}000}$$

Records

Meter records are an invaluable part of meter practice. They are usually in the form of cards. They show the entire history of each meter.

Every meter man has a record system on his own, some quite elaborate with several sets of cards for various kinds of information. Other systems have but one card for each meter with space to enter all necessary information.

Any system should record the following information: Make of meter, amperes, volts, cycles, phase, wires, manufacturer's number Government inspector's number, test constant, dial multiplier if any, date received, test as received, test as left, various places and dates of installation, dates and reasons for each removal, test at each removal "as received" and "as left," remarks as to condition and any repairs that were made, dates of each Government verification, readings each date of bringing in and each date of installation.

Here in Ontario the standard of electrical engineering and Public Electric Utility Systems is the highest. We have power stations, substations, transmission and distribution systems that are the very best and they receive the appreciation and attention they deserve.

Canadian manufacturers are supplying watthour meters that are unsurpassed anywhere in the world for design, workmanship, durability and accuracy. But they do not always receive the attention they deserve.

The larger Public Utility Systems have their well organized efficient meter departments. But many of the systems in the smaller places have no meter department or meter man. In any of these systems will be found some ambitious young man who should be induced to qualify himself as a meter man, and the meters of the system made his special responsibility. He will soon become one of the most valuable men on the system.

Discussion

Mr. Showalter: I don't imagine, in any of your systems, there is any part of your equipment that should receive as much interest and attention as your watt-hour meters. You buy your wire and put it up on your poles and forget it until the wind blows it down. You buy transformers and put them up and forget them until they become overloaded or the fuses blow. You buy your meters and put them in the consumers' premises, look at them once a month, and otherwise forget them. The larger systems have a properly organized meter department, but the smaller systems—nearly all of them from a certain size down—have no one in the system that gives any real thought to the meters. This paper is designed with the idea of providing a sort of guide or handbook, you might say, for those who constitute the majority of this Convention, the smaller municipal electrical utilities, and those of you who are more experienced in the art will contribute very well to this by entering into the discussion, adding what you can as to what information should be given.

Mr. H. F. Shearer, Welland: I would like to ask what the practice of the Toronto system is in regard to the accuracy of the meter when they present it to the Government test man. Is the meter left a small percentage fast, in order to compensate for possible friction during the five-year period when it would be slower, so as to average up on the absolute zero for the five-year period, or is it left exactly zero, taking any losses that might occur in the increased friction during that period?

Mr. J. Eckersley, Toronto: We realize that after a meter is let out, it is inclined to run a little slow. We therefore set it on the fast side, because we know, under ordinary operating conditions, it is going to slow down.

Mr. Shearer: Any definite figure, Mr. Eckersley?

Mr. Eckersley: We keep it a little over 1 per cent.

Mr. J. E. B. Phelps, Sarnia: I think the meters, as they are received from the manufacturers, are a wonderful piece of apparatus. Some years ago, we gathered some data to take to the Department, with the idea of getting the inspection department to allow the meters to be run for a longer period between inspections. We found out, from the data that we received, that the meter was a wonderful piece of apparatus for accuracy over a long period of time, and, as Mr. Showalter points out, it is only a matter of taking care of it.

In the Western District, we have a new man in charge of the inspection department, with headquarters at London. Just recently, he came to Sarnia, and assisted our meter man and our superintendent in re-building our meter test board. He brought our test board more up to date and we appreciated his efforts very much.

Mr. R. H. Starr, Orillia: Mr. Phelps spoke about the meters as they came from the manufacturer

being in pretty good shape. We have had experiences where they have been in poor shape. We began to doubt our standard, and to doubt the man who was doing the testing. Then we traced the thing back. It may have been due to the vibration of the factory walls helping the friction a little, but I think now it has been pretty well overcome. We have been going into the meter question lately; having been on a flat rate for some years, we are putting in meters pretty fast. For the last eighteen months, we have had a meter man instead of allowing just any lineman or foreman inspect meters, pass them and read them and so on. We have cut our complaints down 75 per cent. and most of the complaints now are due to the prejudice against the meter, that it is running when all the lights are off. A man will go up to the house and see some verandah or other light that is alight in some out of the way place and the meter is naturally registering. It has been a great help to myself and has been the cause of cutting down a lot of these complaints.

Chairman: I would like to hear a little more, gentlemen, about the grounding of meters. In my experience, a good many meters come in off the line, and the minute we hang that meter on that rack which is grounded, the fuse will blow. If a meter of that kind is in the basement of a customer's premises, and the customer puts his hand on it he is very apt to get a serious shock. The question of grounding meters, I think came up some time ago, but I am a little bit in doubt as to what came out of it.

Mr. J. G. Jackson, Chatham: I was reminded, by the comment on the grounding of meters, of one or two facts that I have often observed. First, in the ordinary two-wire meter, the current coil may be connected inadvertently on either the ground side or the line side of the meter, and if ground occurred on the circuit, it would make a marked difference in the registration.

Then, again, in three-wire meters, the common practice is to provide only one potential coil operated from one side only of the three-wire supply circuit. That meter will not register at all, if your fuse is blown, or, if there is something defective on the side from which the potential coil is supplied. That seems to me to be a serious defect, that the manufacturers of meters should take it into consideration in the design and manufacture.

Mr. Showalter: The three-wire 220-volt meter is made up with two separate current coils, and one shunt coil. The neutral is usually grounded. If ground occurred, you would have current flowing from one of the side wires to the neutral and registering in the meter, which should be sufficient to blow the fuse. But I think most of the manufacturers are giving meters more internal consideration, testing the insulation before shipment, to ten or twenty times normal voltage. This will enable the meters to protect themselves against the ordinary surges of that value. It appears, in actual practice, that, when you ground your meters, some of

them will come in blown out. I should think those meters really needed attention before, because they had a weakness or some condition that should have been corrected.

Mr. J. W. Purcell, H.E.P.C. of Ont: I would like to ask Mr. Showalter whether, in the selecting of a location, for meters, temperature should be taken into consideration. On farms we very often find that these meters are so placed that outdoor temperatures are practically the temperature of the air surrounding the meter. Is there any information as to whether such conditions would affect the records of the meter or not.

Mr. Showalter: You will find that the older meters have an inherent error due to the varying conductivity of the disc and coil on account of temperature. It will vary up to as high as eight per cent. depending on how low the temperature is. The meters that have been manufactured more recently are compensated somewhat for that, but it does not seem good practice to put a meter where the temperature is low. If oil is used, it will congeal, and introduce quite a serious friction factor in the operation of the meter.

Mr. F. W. Vogt, Hamilton: I would like to ask, what is good practice in using oil in meters. Just how far should we use oil, how little should we use it, and what is good oil to use? We, in the municipalities, have no way of experimenting with oil, as the manufacturers have.

Mr. Showalter: The oil used in watches is the best oil obtainable for the purpose. It is taken from the head of the blackfish and is a peculiar kind of oil that has practically no evaporating tendencies, but it is troublesome. It has a trace of acid in it. Where it is used to oil the jewel in the main rotor, there will be a little red deposit formed. They have introduced a mineral oil that seems to be quite an improvement. As to our own make of meters, we would rather not have any oil used in them. We find, on long run tests, that they remain accurate a great deal longer if no oil is used at all.

Mr. C. W. Lawrence, Sangamo Electric Co: The question of using oil in meters is a question that has been giving a great deal of thought practically all over the world. I was reading an article by a Frenchman the other day on the question of oiling meters; and, as I recall it, he proved that oil, as a lubricant in meters was useless; that the weight of the disc was sufficient, over the small bearing surface, to squeeze out any oil film that may form over the bearing. Now, that is, I should say, perfectly true. It is a very difficult thing to measure. If you figure out the weight of the disc, and measure the area of the bearing surface, you will find that the actual weight runs into tons per square inch, and it is almost inconceivable that the film of oil will stay under the bearing under those conditions. Oil is used principally for the purpose of preventing rust. You can test a meter without any oil, and you will probably get just as good results, as with oil. But in a meter out in service for a long period of years, the pivot is very liable to rust, and if you can get an oil which will prevent that

rust, it will prevent friction. Various manufacturers have tried experimentally using a so-called rust-proof steel, as with stainless steel, but it has not yet been made sufficiently hard to stand up under the stress that it gets in a meter bearing.

Mr. J. W. Peart, St. Thomas: I have one point in mind that nobody has brought up. Why cannot we talk about this problem of cyclometer dials vs. clock dials?

Mr. Showalter: Cyclometer dials are introduced and several companies can supply them; but they do not seem to be in very great demand. If they were, I think all of the companies would be glad to supply them.

Mr. Lawrence: We manufacture meters with cyclometer dials and send them practically to every country in the world, including countries in South America, Europe and in some parts of Africa. They are countries where they cannot educate a man to read a straight clock dial. Looking at a cyclometer dial, it is just the figures that are shown there. It is a well-known fact that a cyclometer jumper type dial meter, on a light load, has an accuracy which is quite variable. That is, while the weight is lifting, the meter has more work to do, and runs slower, but after the weight drops, the meter runs fast. The cyclometer dial of the roller type is like a clock dial reversed. That is, the wheels turn on edge. It works and operates just exactly the same as a clock dial, but necessarily the wheels have to be made fairly small to get it in the meter. We try to get our customers to see our point in using a clock type dial, because they get away from the friction.

Mr. G. A. Brace, Ferranti Meter and Transformer Co: I think we are probably the only company that is putting the cyclometer dial on the market in Canada. It is quite true that most meter readers, especially in the larger places, can very easily read a clock dial. In that case, we furnish an ordinary clock dial; but, in the smaller municipalities, and especially in the rural districts, we generally supply the cyclometer dial. The cyclometer dial is used on practically everything, excepting watt-hour meters. It is a principle that is established, not only in Europe, but all over. Here we are following more the United States practice, undoubtedly, which has gone away from cyclometer dials.

Mr. E. V. Buchanan, London: Very often, we get complaints from a customer about high consumption. When a customer complains about a meter, we make a test, but we feel it is most unsatisfactory to tell a customer that the meter is all right. If we think that he is convinced that the meter is all right, well and good; but, if he doesn't, we usually install another meter alongside the first meter, and leave the two meters there for a period of one month and allow the customer to compare the two meters over that period. We find that that is the only satisfactory way to convince a customer that the meter is right.

Mr. C. E. Brown, Meaford: I would like to ask Mr. Buchanan if he makes a charge for a test of that nature.

Mr. Buchanan: No, we make no charge for that service at all.

Chairman: Do you have many of them?

Mr. Buchanan: I don't believe that the number of complaints of that nature would amount to more than a couple of hundred a year out of about 18,000 meters, and these complaints always come in in the month of October. The reason for that is, that during the cold weather of September, people produce their air heaters, toasters, irons, and everything else that will create heat, and put them on the lines before they have the furnace going, and so run up high bills, and it is very remarkable that these complaints usually come in after the October reading.

Mr. Peart: In that matter of complaints from customers, it is very good practice to take your test standard to the consumer's house and set it up, and get your complainant to watch the hand go round.

Mr. Showalter: I think your public relations are a very important part of your meter practice. Your meter man should be tactful, and should be a man that can approach the public without causing offence, because the public is uninformed. The rotating standard is a most essential instrument, and no system should be without it. You can use it for a great many purposes. You can use it to show just what watt-hours any piece of apparatus uses. You can use it to convince the customer his meter is right, and you can use it to satisfy yourself your system is right.

Mr. J. R. McLinden, Owen Sound: We do everything possible for our complainants, and we don't charge them. If a man has a complaint, we go out and try to convince him with the standard. If he is not convinced then, we take the meter into the shop and ask him to come in with us and see it tested. If he is still not satisfied, we have it tested by the Government test, change the seal, and charge him the price of the test. The result is, we have very few complaints.

Mr. J. S. F. Madden, H.E.P.C. of Ont: I would like to raise the question as to the liability to err of the rotating standard. It is possible that some may carry away the impression that the rotating standard is absolutely reliable and needs no check. But sometimes that may lead to trouble.

Mr. Showalter: The standard, just like the Watt-hour meter, is subject to damage. It needs attention, and it can be checked. You can check it with the Government Inspector when he comes around, and, if it is erroneous, I think any of the manufacturers will be glad to have you send it in and they will have it checked. In the factories there are laboratory standards that are very accurate, and that are referred to when any correction is necessary. The rotating standard is a service article, and due to bumps and jars, will get out of order.

Mr. Peart: How often?

Mr. Showalter: When you have doubts as to its accuracy aroused by the fact that new meters and other meters that you have reasonably good assurance are correct, show errors according to the standard.

Mr. Lawrence: I do not particularly like the name "rotating standard." We have been trying to get away from it and calling them "Portable testing meters." I would advise taking an ordinary meter, testing it carefully, or having the Government Inspector test it, and putting it up on the rack to be left there. That can be used as a check against the portable test meter, or any other meters you want to test. That meter will hold its calibration for a long period.

Mr. Buchanan: I would like to ask Mr. Eckersley if they have any standards in the Laboratory?

Mr. Eckersley: We use an instrument to check against from time to time, but we have no absolute standards. Regarding keeping a small meter, the question was brought up with Mr. Stiver in Ottawa, and he promised that his Inspectors would check it against the Government standard at any time they came along, and I think he practically promised that the Department would help any of the small stations to keep that secondary standard in good condition, so there would be no dispute when the Government Inspector came around.

Mr. Brown: Mr Showalter says, "Ordinary homes, with lights and a range and perhaps a water heater, are metered with a 25-ampere meter." A little further, he says "The size of the meter applied to any residence service need not be greater than one-third of the rating of the total connected load." Now, it seems to me that, for a range only, probably the 15-ampere meter would be nearer the mark.

Mr. Showalter: I said something in the beginning about the sizes of meters, being the outside value, as expressed. Nevertheless, it is common practice to use a meter considerably smaller than the maximum load you expect to carry. If you will put a chart meter on the average house, you will find that it does not use anywhere near the connected load at any time. So I made the recommendation one-third, not as my advice, but as copying your practice.

Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities

Report of Pension and Insurance Committee

AT the Convention at Niagara Falls on June 24th, 1925, there was a discussion in connection with developing a Pension and Insurance Plan for the employees of the municipally owned electrical utilities in Ontario. This discussion resulted in a resolution appointing a Committee to investigate the matter. Information was collected by the Committee in regard to details necessary to make the investigation and the assistance of the Hydro-Electric Power Commission of Ontario was requested so that a complete analysis could be made and a report developed. It was also found that it would be necessary to obtain legislation enabling the Municipalities to make provision for insurance and pension for the employees.

At the last meeting of the Legislature Bill No. 171 was introduced and passed and as advised at the Convention last summer, an Order-in-Council was passed on June 30th, placing "The Power Commission Insurance Act, 1927" on the statutes.

As has been reported previously, it was found that it would not be practicable to enlarge the present Plan for Pension and Insurance of the employees of the Hydro Electric Power Commission to include the employees of the Municipalities, and for this reason, plans were requested from various insurance companies. It was found to be extremely difficult to make a comparison between the benefits given by the different plans and the costs put forward by these plans. In developing the plan for the Municipalities, the basic principle was followed, that the benefits to the employees under such a plan, should be similar to the benefits under the Hydro Electric Power Commission Plan, to employees of the Hydro Electric Power Commission. It was finally decided that the most practicable method of procedure would be to develop specifications for the plan and to request interested Insurance Companies to present tenders to meet the specifications accompanied by draft contracts.

In September, 1927, specifications having been drawn, they were sent out with an accompanying letter to all Insurance Companies which had been negotiating in regard to the matter. The information was also given to any other Insurance Company who asked for it.

On receipt of the tenders and draft contracts, these were turned over to the officers of the Hydro-Electric Power Commission who, with Pro-

fessor M. A. Mackenzie, a Fellow of the Actuarial Society of Great Britain, made a complete analysis and presented reports to the Committee. Various conferences between the Committee and the Officers of the Hydro Electric Power Commission and Professor Mackenzie, were held with a view to clearing up certain difficulties which had arisen, and to make possible the development of a letter to the Hydro-Electric Power Commission. A letter, together with the final form of the draft contract most favoured by the Committee, was presented to the Hydro-Electric Power Commission at an interview of the Committee and the Commission on December 31st, 1927. The Chairman of the Commission advised the Committee that the matter would receive early consideration and the Committee would be advised of the action of the Commission.

To make this available to Municipalities, it will be necessary for the Commission to receive by Order-in-Council, authority to enter into the contract which matter no doubt is in hand.

The plan when approved by the Hydro-Electric Power Commission of Ontario, will be presented to the various Municipal Commissions individually, and should receive the early careful and serious consideration from the various Commissions so that it can be made effective in the very near future.

Respectfully submitted,
(*Sgd.*) V. S. McIntyre,
Chairman.

Hydro on the Farm

Blest are the Farmers with HYDRO to-day,
Installed in their houses and barns.
Not a luxury, no. They make it pay;
Go to them, talk with them, hear what they say,
about HYDRO.

Sometimes they're late getting back home at night,
After a journey to Town.
HYDRO'S turned on, House and Barn are lit bright,
They're thankful that they have such wonderful light,
as HYDRO.

The water for stock perhaps is much lower,
But the motor soon pumps up some more.
"Old armstrong" is very much harder and slower
They're thankful that they have such wonderful power
as HYDRO.

Sometimes the chopping has gotten behind
And the cattle need grain right away,
The Motor is started, commences to grind,
Power so efficient is hard to find
as HYDRO.

His chickens can see to get their feed,
He does not fret about that.
In production of eggs his chickens lead
Because they can have all the light that they need
in HYDRO.

His children have no inclination to roam
To the Towns and the Cities to work.
They need not travel o'er land and o'er foam,
All the up-to-date comforts they may have at Home
with HYDRO.

The cooking is done on a Range ever bright
With no ashes or fumes to provoke.
The clothes are Electrically washed pure white;
Electricity irons the clothes just right
with HYDRO.

The cleaning is done the electrical way
And the Housewife is not all fagged out.
The Radio set is able to play
And many more wonders performed to-day
with HYDRO.

So you that have HYDRO, help those that have not
And by so doing help yourselves
To get cheaper rates than you've already got
By boosting so that we may get a whole lot
to take HYDRO.

H. H. Pegg, Supt., Tillsonburg R.P.D.

A.M.E.U. Reports

Report of Rates Committee

To

The President & Members of Association of Municipal Electrical Utilities.

Your Rates Committee beg leave to report, as follows :—

Since the June Convention, one meeting of this Committee was held at Kitchener on November 29th last and was attended by the following Members :—

Mr. V. S. McIntyre, Kitchener, Chairman of the Committee, Messrs. J. G. Archibald, Woodstock ; H. J. McTavish, Toronto; O. H. Scott, Belleville; R. L. Dobbin, Peterboro; E. V. Buchanan, London; R. T. Jeffery, H.E.P.C. of Ontario, Toronto; J. J. Heeg, Guelph; J. W. Peart, St Thomas; E. I. Sifton, Hamilton; W. R. Catton, Brantford; Geo. Grosz, Waterloo; and S. R. A. Clement, H.E.P.C. of Ontario, Toronto.

The Minutes of this meeting are, as follows :—

It was moved by Mr. O. H. Scott and seconded by Mr. J. J. Heeg, THAT, Mr. S. R. A. Clement be appointed Secretary of the Committee.—Carried.

The Chairman read a number of letters in reference to the rates in use for service, which are outlined in the following :

Letter from Mr. E. V. Buchanan, London, expressing his feeling that it is undesirable to change rates frequently unless there is any serious local complaint, being in favor of letting the prevailing rates stand. He expressed approval of the domestic rates used by Hamilton, that is, a Service Charge of 33c. per month for a 2-wire service and 66c. per month per month for a 3-wire service. He also expressed the belief that the present commercial rate was too high in comparison with the domestic rates, suggesting that the first rate apply to 150 hours' use per month and that the follow-up rate be made lower, this being done to encourage the long-hour commercial user.

A letter from Mr. J. W. Peart suggested that the commercial lighting rate reflected serious complications that are not grasped by the average layman. He did not feel in a position to make any suggestions at this time.

A letter from Mr. R. L. Dobbin expressed approval of the new domestic rate but questioned its application where appliances are used. He also expressed approval of the commercial rate, suggesting that it be made still more of the same character as the domestic rate. He questioned the sale of Class "C" power. Reference was also made to the present system of Government meter inspection, reminding the Committee of the suggestion made at the Bigwin Convention that the Government standards should be placed in each meter testing department.

Mr. E. I. Sifton made suggestions regarding the analysis of operation.

A letter from Mr. E. M. Ashworth made suggestions regarding the proceedings of the Rate Committee.

The various points brought up in these letters were discussed by the Committee but no recommendations were made suggesting changes.

Discussion then turned to the ruling of the Public Utilities Act in reference to the collection of arrears for service. There were no suggestions forthcoming from discussion of this subject.

The question of collection of accounts of one utility for another on account of a consumer having moved to another town was discussed. It was shown that there is considerable co-operation among some municipalities in collecting such accounts, but there is no general understanding as to the manner in which the utilities in general could assist one another.

It was moved by Mr. E. I. Sifton and seconded by Mr. H. J. McTavish, THAT the municipalities agree to co-operate in so far as possible in the collection of accounts in arrears of customers moving from one municipality to another and that the Hydro-Electric Power Commission of Ontario be asked to prepare a card form of inquiry to be used in such cases.—CARRIED.

Mr. E. V. Buchanan read a letter clipped from the New York *Times* drawing comparisons and criticisms of the cost of service in Ontario municipalities so as to give the impression that the cost of service in Ontario municipalities did not compare favorably with that in some United states localities, using information obtained from the annual report of the Hydro-Electric Power Commission of Ontario. This was more particularly in reference to the cost of power to industrial users and was obtained by improper use of the information given.

It was moved by Mr. E. V. Buchanan and seconded by Mr. J. G. Archibald, THAT the Hydro-Electric Power Commission of Ontario be asked to add two columns in statement "D" of the annual report showing the kilowatt hours used for power and the average price per kilowatt-hour.—CARRIED.

Mr. H. J. McTavish then presented a suggested resolution from Mr. E. M. Ashworth. This resolution was discussed, clause by clause, and some slight changes made in the wording, after which being regularly moved by Mr. H. J. McTavish and seconded by Mr. R. L. Dobbin, it was adopted in the following form :

"RESOLVED, that the Secretary shall record the proceedings of each meeting of the Rate Committee of the Association of Municipal Electrical Utilities ; that the minutes shall include the text of all formal resolutions, either defeated or passed, and a record of the voting of each member on each resolution when called for ; that the minutes shall include communications from Municipal Commissions and a record of the manner in which each communication is dealt with ; that a copy of the minutes of each meeting shall be forwarded to each member of the Committee within one month of the date of the meeting ; that a copy of each proposed recommendation of the Committee shall be forwarded to all Municipal Commissions affected and an opportunity afforded for the consideration of objections to such

recommendations prior to presenting the same to the Association."

A number of subjects were then discussed by the Committee in an informal manner with the object of laying before the Committee questions that would probably come up in the future but did not as yet require immediate action. These referred to the use of relays to limit the domestic demand where a water heater, grate or other appliance is installed together with an electric range ; the use of motors driving blowers on domestic furnaces.

Other subjects that were discussed for the purpose of getting a better understanding of the present rate system were the reason for allowing a Class "C" power user 10 per cent. discount not given to Class "A"; the question of a consumer cancelling his contract for the purpose of reducing his service charge ; the discrepancy of service charge as between domestic, commercial and power users ; the operation and effect of rates for commercial service.

After the discussion of these subjects there being no further business the meeting adjourned at 4:30 p.m.

All of which is respectfully submitted.

(*Sgd.*) V. S. McINTYRE,
Chairman

Report of Merchandizing Committee

To

The President & Members of
Association of Municipal Electrical Utilities

A meeting of the Merchandising Committee was held on December 16th to discuss various important matters in connection with the sale of appliances by Hydro Shops and beg to report as follows :

The lien note form recommended by the Legal Department of the Commission as covering all of the requirements of the law in connection with the sale of appliances on a time payment basis was submitted to the Committee for its perusal and after discussing the various clauses in the form it was moved by Mr. A. W. J. Stewart, seconded by Mr. H. F. Shearer, that the form as submitted be sent out to all Hydro Shop Municipalities as a guide to assist them in preparing their own lien notes when the need arises for such.

On account of varying conditions in different localties it is not possible to have a standard to apply to all Municipalities so that this form will have to be altered slightly to meet local conditions.

The following is a reproduction of the draft form :

HIRE PURCHASE AGREEMENT

This Memorandum of Agreement made on the day of A.D., 19 .

Witnesseth that I, of the of , in the County of hereinafter

called the Hirer, have hired and received of
hereinafter called the Owner, the articles described in the Schedule on the back hereof ; and for the rent and use of the same have agreed to pay the total sum of Dollars as follows :—

together with interest on the unpaid instalments at per centum per annum payable with each instalment.

2. The title, ownership and right of possession of said articles shall remain with the Owner until the whole of the said total sum and interest is paid.

3. If default is made in any of the said instalments, or if goods or premises of the Hirer be seized under distress or execution, or if the Owner has reason to think the hire of the said articles unsafe, the Owner shall be at liberty, without notice or process of law, to enter into and upon any premises where the said articles or any of them may be and resume possession of said articles and to take away and sell the same without the Hirer having any recourse against the Owner for moneys paid on said total sum or for any damage done in removing said articles.

4. It is expressly agreed that promissory notes or renewals thereof given for, or on account of, said instalments shall not be considered as payment thereof, unless or until such notes or renewals be paid at maturity, and shall in no wise, even during their currency and before their due date, affect, delay or postpone the rights of the Owner herein contained.

5. The Hirer shall during the said term keep and maintain, the said articles in a good state of repair and condition (reasonable wear and tear excepted) and shall not during the said term suffer the said articles, or any of them, to go out of his possession or remove or allow to be removed the said articles from the premises named herein except with the written consent of the Owner, and shall not cause or suffer any of the said articles to be affixed to the premises on which they, or any of them, shall be used during the said term in such a way that they shall become fixtures. The Hirer shal! free and release the Owner from all claims for damages or otherwise arising out of the use of the said articles during the said term.

6. It shall be lawful for the Owner, or its agent, at all reasonable times, to enter the said premises for the purpose of viewing the state and condition of the said articles.

7. The Hirer agrees that he will keep the said articles insured during the currency of this agreement with an insurance company designated by the Owner for the benefit of the Owner, as its interest may appear covering loss by fire, theft and general liability.

8. The Owner agrees to allow possession of said articles to remain with the Hirer until the happening of a default or event as set out in clause

3, and on the full payment of the said total sum as aforesaid, together with all expenses and interest contracted in connection therewith the title and ownership of said articles shall pass to the Hirer.

9. The Hirer shall not assign this agreement unless with the written consent of the Owner.

10. The Hirer hereby acknowledges receipt of a copy hereof.

11. The Hirer hereby certifies that he is the (tenant/owner) of the premises known as

IN WITNESS WHEREOF I have hereunto set my hand and seal the day and year first above written.

SIGNED, SEALED AND DELIVERED }
In the presence of : }

SCHEDULE.

In discussing the question of more suitable and more frequent advertising for not only the sale of merchandise by Hydro stores but to increase the interest of consumers in the benefits of electricity, it was felt that some good would come out of the distribution by a central advertising agency among the different municipalities of cuts and advertising material so that the smaller municipalities would get the benefit of the advertising experience of some of the larger municipalities without excessive cost.

It was felt that more advertising of an educational nature should be done as there seems to be a falling off of this kind of effort in Hydro Municipalities.

The Toronto Hydro representative, Mr. Stewart, submitted a number of advertisements which the advertising agency in their employ prepares for them periodically and it was suggested in fact it was moved, by Mr. O. M. Perry, and seconded by Mr. Phelps, that the Committee investigate the possibility of having the Toronto Hydro Advertising Agency supply the various municipalities desiring them cuts or mats or other advertising material in the Toronto Hydro advertising program of which they can make use and an effort is now being made to ascertain from this agency what the cost would be and how far their service could be extended to give the desired result.

On account of the fact that there was no place provided in the Convention program for a merchandising paper, it was felt that a special effort should be made to have a suitable speaker address the Convention on a suitable subject and a resolution was passed that an endeavour be made to secure a speaker who would inject a

little more enthusiasm into the merchandising efforts of Hydro Municipalities.

Considerable discussion was given to the question of the declining efforts on the part of Hydro Municipalities in the matter of merchandising. The opinion was expressed that there seems to be a general slackening of effort to not only sell appliances but to educate the public in their use. Recognizing the necessity for Hydro Municipalities to sell and service appliances not only to sell more electricity but to combat the efforts of competitive utilities, particularly Gas Companies, the Committee are of the opinion that more attention should be given to merchandising by Hydro Municipalities than seems to be the case. Particular stress was laid on the necessity for co-operation with electrical dealers and contractors in order to bring about a concerted effort along the line of competition with other utilities rather than have the efforts of both defeated by lack of co-operation.

Respectfully submitted,

(*Sgd.*) OSWALD H. SCOTT,
Chairman.

Report of Regulations and Standards Committee

To

The President and Members,
Association of Municipal Electrical Utilities

Your Regulations and Standards Committee for the year 1927, beg to report there was held in Toronto on November 18th a meeting of the Rules and Regulations Committee (Inside Work) of the Hydro-Electric Power Commission of Ontario.

The following information is extracted from the minutes of the meeting. The meeting was held primarily to consider the question of recommending to the Commission, that the Canadian Electrical Code, Part I, be adopted as the Commission's Rules and Regulations governing Electrical Installations for Buildings, Structures and Premises.

It was brought to the attention of the Committee, that the Canadian Electrical Code had been copyrighted by the C.E.S.A., and after some discussion, it was moved and carried unanimously, that the Association be requested to waive its copyright in connection with the Canadian Electrical Code and note the fact in their official records.

The Committee was asked to consider the question as to whether or not the Canadian Electrical Code should be adopted. It was felt that a few revisions were needed and the following instanced,—

Rule 503 Clause (*m*). No. 8 should be changed to No. 10 (N.B. No. 10 was called for by the draft considered in Winnipeg, but the Committee there changed it to No. 8 to make it conform to the N.E. Code.

Rule 403, Clause (*a*) *2nd paragraph.* "two No. 6 or three No. 8 B. & S. Gauge Conductors"—the rule should state that these sizes are minimum.

Rule 507 Clause (*f*). The words "except at ceiling outlets, where boxes ½ inch deep may be used," should be deleted.

Rule 512, Clause (*a*) (*4*). "buildings in which gasoline or other

volatile materials or explosives are handled" should be changed to "buildings in which hazardous condions exist."

Rule 2007, Clause (d). That this should be revised. Choke coils are not necessarily an inherent part of lightning arresters and any device or arrangement having a choking effect is actually forbidden by the Ontario Lightning Rod Act.

Rule 3203, Clause (b). That specific mention shall be made of the fact that *switches*, unless in gas-tight cases are not permitted.

Rule 3701, Clause (b). That this be extended to include Provincial Authorities, as some of them have jurisdiction over certain matters affecting Radio work.

Rule 3701, Clause (e). Steel frame work is not necessarily grounded, especially in barns. The requirements should take cognizance of this fact.

Rule 3701, Clause (f). This conflicts with the Ontario Lightning Rod Act and should be modified.

Rule 2702, Clause (a). Not sufficiently clear or comprehensive.

This clause is hardly needed and might be deleted.

Rule 3702, Clause (f). The "3 feet" specified, should be changed to 12 feet. Mr. Lewis here stated that he considered the Hydro "Radio" rules to be on the whole, better than these, and, after being informed that the C.E. Code Radio Rules had been handled by a special Sub-Committee, consisting of men expert in Radio work, stated that Radio Experts are inclined to minimise the danger connected with such work.

Rule 3702, Clause (i). That the expression "form a shunt around the lightning arrester" should read "form a shunt around the receiver"

Rule 3702, Clause (k). That the words "may be left uninsulated" might as well be left out.

The foregoing points were noted by the Secretary for future use in connection with the revision of the C.E. Code.

The Chairman asked for a motion recommending the adoption of the C.E. Code by the Commission.

After some discussion, the following motion was put by Mr. Ostrom, seconded by Mr. Driscoll.

(1) That this Committee desires to express its approval of the Canadian Electrical Code and its appreciation of the evident care and thought that has been bestowed by those who have worked upon it.

(2) That this Committee requests the Hydro Electric Power Commission of Ontario to adopt publication C. 22—1927, of the Canadian Engineering Standards Association entitled the "Canadian Electrical Code, Part I" as the Commission's Rules & Regulations governing electrical installations for Buildings, Structures and Premises."

(3) That the Canadian Engineering Standards Association be asked by the Commission to furnish satisfactory assurance regarding the following:—

(*a*) That the Association has established, or definitely intends to establish, in the near future, adequate staff and facilities necessary to keep

the Canadian Electrical Code up-to-date in every respect.

(*b*) That the Association will issue a revised edition of the Canadian Electrical Code, Part I, before the end of the year 1928 and at least every alternate year thereafter.

This motion was *carried unanimously.*

Mr. Driscoll moved that, in the event of the Commission adopting the C.E. Code, the "Ontario Sub-Committee on Canadian Electrical Code" be enlarged to include all electrical interests now represented on the Commission's Rules & Regulations Committee (Inside Work).

Mr. Peasnell seconded this motion, which was *carried unanimously.*

The Secretary then read some correspondence of the Commission relating to the question of farmers doing their own wiring. This matter had been raised by Prof. W. C. Blackwood of the Ontario Agricultural College at Guelph. After some discussion, Mr. Driscoll moved that the Committee recommend to the Commission, that encouragement should not be given to the carrying out of electrical installation work by any but practical wiremen who have served a proper apprenticeship. Mr. Ostrom seconded the motion, which was *carried unanimously.*

Following upon the recommendation of the Committee as recorded above, the Commission has since adopted the Canadian Electrical Code Part I, and the approval of the Lieutenant-Governor in Council for this action has been formally received. The Commission will publish in the very near future the eighth edition of its "Rules and Regulations governing Electrical Installations in Buildings, Structures and Premises" embodying the Canadian Electrical Code, Part I.

All of which is respectfully submitted,

(*Sgd.*) R. J. SMITH,

Chairman.

Auditor's Report

January 10th, 1928.

Mr J. J. Heeg,
President
Association of Municipal Electric Utilities of Ontario.

Dear Sir:

We beg to advise you that we have audited the books of the Association of Municipal Electric Utilities for the calendar year 1927, and find that the cash received and recorded by the Treasurer agrees with the Secretary's statements. These disbursements are supported by vouchers duly authorized and passed by both President and Secretary, and the cash balance is in accord with the account at the bank.

We respectfully submit herewith statement of Receipts, Disbursements and Assets.

Yours very truly,

(*Sgd.*) W. G. Pierdon,
H. P. L. Hillman.
Auditors.

Statement of Receipts, Disbursements and Assets for Year Ending December 31st, 1927

RECEIPTS

Cash in bank Dec. 31, 1926		$ 686 93
Membership fees:		
Utilities (159)	$1,242 00	
Commercial (36)	360 00	1,602 00
Convention receipts		3,196 00
O.M.E.A. donation		253 92
Interest earned on deposits		24 39
Interest earned on bond		27 50
Sale of Reporter's copies		18 75
		$5,809 49

DISBURSEMENTS

Members' traveling expenses		186 05
General printing		90 79
Stamps and express		39 67
Bank exchange		20 59
Salaries, Secretary and Treasurer		250 00
Convention Expenses:		
Luncheons	3,301 00	
Entertainment	550 93	
Reporting	217 80	
Badges	168 12	
Printing	151 18	
Sundry expenses	130 12	4,519 15
Balance		703 24
		$5,809 49

ASSETS

Cash in bank		$ 703 24
Dominion of Canada 5½% 1934 bond (par $500. 00) purchase price		513 50
Lantern and fixtures	243 45	
Less 5% per annum written off	97 38	146 07
		$1,362 81

Minutes of Convention

The twenty-second convention was held at the King Edward Hotel, Toronto, on Wednesday and Thursday, January 18th and 19th, 1928. At 12.30 p.m., on the 18th, the delegates to the convention joined with the Electric Club of Toronto for luncheon when an address was given by Mr. G. W. Austin, Manager, Electric Service League, Toronto.

The first session of the convention opened at 2.30 p.m., when the President, Mr. J. J. Heeg, gave a short address welcoming the delegates to the convention.

The Report of the Auditors covering the year 1927 was presented, which on the motion of Mr. P. B. Yates, seconded by Mr. R. H. Starr, was adopted.

Two letters from Mr. W. P. Dobson to the President, explaining the situation as regards the work of the sub-committee acting with the Canadian Electrical Association on the question of having the re-seal period of watthour meters extended, was read for the benefit of the delegates.

Mr. V. S. McIntyre, Chairman, Rates Committee, presented a report from that committee and moved its adoption. On being seconded by Mr. J. G. Archibald, the motion was carried.

Mr. O. H. Scott, Chairman, Merchandising Committee, presented a report from that committee and moved its adoption. The motion was seconded by Mr. J. E. B. Phelps, after which it was carried.

A report from the Regulations and Standards Committee was presented by Mr. R. J. Smith, Chairman, who moved its adoption. Mr. E. V. Buchanan seconded this motion, after which it was carried.

Mr. G. D. Floyd, Electrical Engineering Dept., H.E.P.C. of Ontario, read a paper entitled "Some Factors Involved in Bulk Transmission of Power." Discussion following this paper was by Messrs. J. E. B. Phelps and E. V. Buchanan.

This session was conducted under difficulties owing to the accoustics of the room in which it was held and noises from the outside interfering.

It was moved by Mr. J. E. B. Phelps and seconded by Mr. E. V. Buchanan, THAT the Executive be asked to recommend to the Hydro-Electric Power Commission of Ontario through the Ontario Municipal Electrical Association, the inclusion in the proposed new building of the Commission of an auditorium large enough for the meetings of the Associations.—*Carried.*

The scrutineers presented their report showing the result of the election of officers for the year 1928, being as follows:

President—J. G. Archibald.
Vice-Pres.,—A. W. J. Stewart.
Secretary—S. R. A. Clement.
Treasurer—D. J. McAuley.
Directors—O. H. Scott, J. E. B. Phelps and V. S. McIntyre.

District Directors.

Niagara District—H. G. Hall.
Central District—V. B. Coleman.
Georgian Bay District—J. R. McLinden.

Eastern District—R. J. Smith.
Northern District—T. W. Brackinreid.

The newly elected President and Vice-President gave short addresses thanking the delegates for having honoured them by electing them to those offices, after which the session adjourned.

At 6.30 p.m., this Association met with the Ontario Municipal Electrical Association for the convention dinner. Mr. Samuel Harris, President, Navy League of Canada, was the guest of the two Associations on this occasion, and gave an address on the work of the Navy League.

The second session of the convention opened at 9.50 a.m., on Thursday, January 19, when Mr. Joseph Showalter, Canadian Westinghouse Company, Limited, presented a paper on "Canadian Watthour Meter Practice." Discussion following Mr. Showalter's paper was by Messrs. H. F. Shearer, J. Eckersly, J. E. B. Phelps, R. H. Starr, J. G. Jackson, J. W. Purcell, F. W. Vogt, C. W. Lawrence, E. V. Buchanan, J. W. Peart, G. A. Brace, C. E. Brown, J. R. McLinden, J. S. F. Madden and E. R. Lawler.

The session then became a joint session with the Ontario Municipal Electrical Association, Mr. J. J. Heeg continuing in the chair. Mr. F. A. Gaby, Chief Engineer, H.E.P.C. of Ontario, gave an address on "The Progress of the Hydro-Electric Power Commission in 1927."

Mr. V. S. McIntyre, as Chairman, had presented a report of the Pension and Insurance Committee of the two associations, and this was now discussed. The following resolution had also been presented:

Moved by Mr R. H. Starr and seconded by Mr. E. V. Buchanan.

THAT the Pension and Insurance Committee of the Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities, as at present constituted, be continued during the coming year and be empowered to take such action in co-operation with the Hydro-Electric Power Commission of Ontario as may be necessary to bring the plan recommended by the Committee into effect; and that the Committee be urged to use every effort to the end that the plan may be presented to the individual Municipal Commissions with the least possible delay —*Carried.*

After the discussion on this report the session adjourned.

At 12.30 p.m., the Association met with the Ontario Municipal Electrical Association for luncheon when an address was given by Mr. Stewart Lyon, former editor of the Globe.

The afternoon session opened at 2.30 o'clock as a joint session of the two Associations, Mr. C. A. Maguire, President, O.M.E.A., being Chairman. An address was given by Mr. Geo. Wright, Commissioner Toronto Hydro-Electric System, and Commissioner Toronto Transportation Commission on "Transportation Problems."

The meeting then turned to a session of this Association with the President, J. J. Heeg, as Chairman.

A playlet, "Hiring a Lineman" was presented. Mr. W. G. Hanna, Legal Dept., H.E.P.C. of Ontario

gave an address entitled "Some Notes on the Law Relating to Public Utilities." Following his address Mr. Hanna answered some questions by the delegates.

The President then gave a short address thanking the Association and officers for assistance given him during his term of office, and expressing good wishes for his successor.

President-elect, Mr. J. G. Archibald then made some suggestions for the coming year, and advised of an Executive meeting to be held immediately after the close of the convention.

On motion to adjourn the convention proceedings were then concluded.

The register shows the total number of delegates attending the convention to have been 300, being classified as follows:

Class A	—	101
Class B	—	95
Commercial	—	59
Associates	—	34
Visitors	—	11

There were 254 delegates present at the first convention luncheon, 322 at the convention dinner and 293 at the second convention luncheon.

Minutes of Meeting of the Executive Committee

A meeting of the Executive Committee of this Association was held at the King Edward Hotel on January 19th, 1928, the following being present:

Messrs. J. G. Archibald, Chairman; T. J. Hannigan, R. J. Smith, V. B. Coleman, J. J. Heeg, O. H. Scott, A. W. J. Stewart, J. E. B. Phelps, H. G. Hall, D. J. McAuley and S. R. A. Clement.

A letter from the Manager of the Clifton Hotel advising dates that will be available for the Association in the event of it holding its summer convention at Niagara Falls was read. After discussion of this subject, it was moved by Mr. J. E. B. Phelps and seconded by Mr. H. G. Hall, that the summer convention of this Association be held at the Clifton Hotel, Niagara Falls, on June 20, 21 and 22, 1928.—*Carried.*

The meeting then proceeded to draft various committees for the Association for 1928, the following being finally decided upon:

Papers Committee: Messrs. O. H. Scott, Belleville, Chairman; V. S. McIntyre, Kitchener; W. R. Catton, Brantford; Frank T. Wyman, Packard Electric Co., St. Catharines; Jos. Showalter, Canadian Westinghouse Co., Toronto; W. P. Dobson, G. F. Drewry and G. J. Mickler, H.E.P.C., Toronto.

Convention Committee: Messrs. A. W. J. Stewart, Toronto, Chairman; J. E. Teckoe and H. P. Stephens, Niagara Falls; H.F. Shearer, Welland; M. B. Hastings, Powerlite Devices, Ltd., Toronto; H. C. Barber, Standard Underground Co., Toronto; F. Mahoney, Canadian General Electric Co., Toronto; and J. W. Purcell, H.E.P.C., Toronto.

Regulation and Standards Committee: Messrs. R. J. Smith, Perth, Chairman; V. B. Coleman, Port Hope;

J. R. McLinden, Owen Sound; Geo. Grosz, Waterloo; E. V. Buchanan, London; W. P. Dobson, H.E.P.C., Toronto; and A. G. Hall, Electrical Inspection Dept., Toronto.

Committee on Accident Prevention and Health Promotion: Messrs. H. G. Hall, Ingersoll, Chairman; C. T. Barnes, Oshawa; J. G. Jackson, Chatham; R. L. Dobbin, Peterboro; C. E. Brown, Meaford; C. E. Schwenger, Toronto; C. W. Alfred, London; F. C. Adsett, Trenton; T. C. James, G. F. Drewry and Wills Maclachlan, H.E.P.C., Toronto.

Merchandising Committee: Messrs. J. E. B. Phelps, Sarnia, Chairman; O. M. Perry, Windsor; O. Thal, Kitchener; A. O. Hunt, London; W. H. Childs, Hamilton; C. W. Burns, Walkerville; I. N. Pritchard, Chatham; A. B. Scott, Galt; A. W. J. Stewart, Toronto; J. J. Heeg, Guelph; O. H. Scott, Belleville; H. F. Shearer, Welland; and G. J. Mickler, H.E.P.C., Toronto.

Rates Committee: Messrs. V. S. McIntyre, Kitchener, Chairman; P. B. Yates, St. Catharines; E. I. Sifton, Hamilton; E. M. Ashworth, Toronto; R. L. Dobbin, Peterboro; E, V. Buchanan, London; A. B. Scott, Galt; Geo. Cross, Waterloo; O. M. Perry, Windsor; D. B. McColl, Walkerville; J. W. Peart, St. Thomas; and all the members of the 1928 Executive Committee.

It was moved by Mr. O. H. Scott and seconded by Mr. R. J. Smith, that the Committees as drafted be confirmed.—*Carried.*

Mr. Scott suggested that a note be published in the Bulletin asking that suggestions for papers to be read at the Summer Convention be forwarded to him.

It was also suggested that Mr. Archibald, President, submit a letter for publication in the Bulletin asking the utilities to write the Association on any subject or questions concerning them that might be of general interest.

It was moved by Mr. J. E. B. Phelps and seconded by Mr. O. H. Scott, that the Secretary and Treasurer be given an honorarium of an amount equal to that paid to them in the former year. —*Carried.*

It was agreed that the next meeting of the Executive Committee should be held sometime in April, when the Chairmen of the various committees would come prepared to suggest plans for the Summer Convention. The date of this meeting will be decided upon later.

There being no further business the meeting adjourned.

Summer Convention Dates

Having learned that the dates for the Summer Convention chosen at the Committee Meeting are the same as those of another convention that will be attended by some of the delegates, the Executive Committee has changed the dates of the A.M.E.U. Convention to June 13, 14 and 15, 1928.

Further Convention Reports will be published in the March Bulletin

Grounding Devices and Equipment

January 23 1928

The Editor of the Bulletin:

I have just read in the December issue of the Bulletin Mr.Buchanan's criticism of the double electrode method of constructing artificial grounds.

We must not lose sight of the object of the proposed grounding scheme which is to obtain reasonably satisfactory artificial grounds for grounding work on the customers premises under every day working conditions. The scheme suggested has three distinct features.

1. It provides an artificial ground consisting of two electrodes instead of one. This is highly desirable because, as a matter of record, one electrode seldom gives a sufficiently low resistance.

2. It provides a working procedure whereby wiring systems which have a resistance of more than 25 ohms to ground will not be connected up to a distribution system which itself has a resistance of more than 25 ohms to ground. We take it that the desirability of this is granted.

3. It provides a procedure whereby the owner of the distribution system will receive certain information as to the resistance of any artificial ground used for grounding the interior wiring system. It is not necessary that the exact resistance be known, in fact it might almost be said that there is no exact resistance.

As to the accuracy of the measurements, would say that if the average resistance of the earth between the two electrodes, separated six feet apart, is the same as the average resistance of the earth surrounding each electrode for a distance of six feet then the readings are theoretically correct, and the theory has been confirmed by plenty of tests including a considerable number made by myself. Because over 80 per cent. of the total resistance lies in the first foot of earth surrounding the electrode the resistance of the other four feet between the electrodes need not give us much concern. As soon as we get into conditions where there is a great variation in the average resistance of the earth immediately surrounding the two electrodes the readings are no longer accurate, but in actual practice these variations are not sufficient to produce such inaccuracy in the readings as to make them by any means useless or dangerous. The difference between the readings which ordinarily would be obtained and the true ground resistance will generally be less than the variation in the resistance of any given ground between a rainy season and a dry season, or between frozen and unfrozen ground conditions. For instance, in the case of a three to one variation, which is improbable, our estimate would be about 50 per cent. high. When we set a limit for artificial ground resistance, without specifying all of the conditions under which the resistance is to be measured, as the Code does, we are necessarily leaving a much greater leeway than is likely to be involved by any variation in the aver-

age resistance between electrodes, as compared with that of the earth surrounding the two electrodes.

Let us look for a moment at the first case which Mr. Buchanan cites. Under what actual operating conditions is it likely that a wireman would be installing an artificial ground where subsurface metallic structures exist? Where these exist the Code requires that they be used for grounding purposes and if their presence is unknown, and electrodes are driven down into contact or near contact with them, then I think we need not worry about the resistance of that particular artificial ground, because it will be very much lower than the average.

Take the second case mentioned, namely that where one of the electrodes is in earth of especially high resistance, which is a more probable case because sometimes one electrode might be driven into rock or gravel fill while the other electrode might be in good conducting soil. Under these conditions our series test leads us to believe that our ground resistance is much higher than it actually is with the result, presumably, that either more elaborate tests will be made or an additional electrode installed, but since we are obviously working under more or less uncertain soil conditions this is hardly objectionable, and in fact it is desirable in any case where the series resistance exceeds 100 ohms, irrespective of how the resistance is divided between the two electrodes.

If in any particular territory the artificial house grounds are now being tested by more accurate methods and two electrodes are being installed where the resistance of one is above 25 ohms, then I would not suggest the substitution of the proposed method for the existing conditions, but I do not know of any place where that is being done and I do know that in the very great majority of cases it is not being done. In any case I think that the proposed method would give just about as good practical results and at a very much lower cost.

Very truly yours,

(Sgd.) S. W. Borden, Manager.
Groundulet Company.

Correction

In the January Bulletin, Page 29, it is stated that the voltage of the new Oshawa-Port Hope line and of the Whitby Station will be 4,400, these should have been stated as 44,000 volts.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

List of Electrical Devices, Material and Fittings

Approved by the Hydro-Electric Power Commission of Ontario in January, 1928.

Appliances

AD-VANCE WINDOW SERVICE CORPORATION, (Submittor), 111 Westchester Square, New York, N.Y.

Electric Window Display Signs.

* * * *

THE ARTHUR-EWART CO,, 21 King Street, East, Toronto, Ont.

"The Presto Display" electric window display sign.

* * * *

THE BING CORPORATION, 33 East 17th Street, New York, N.Y.

Electrically-lighted toy motion pictures machines and magic lanterns for home use. "Bing."

* * * *

THE BOSS WASHING MACHINE CO., Norwood station, Cincinnati, Ohio.

Portable motor-driven Washing Machine. "Banner" Model 35. Agitator type.

* * * *

CANADIAN LECTROMELT FURNACE LTD., (Submittor), 37 Niagara St., Toronto, Ont.

Moore Rapid Lectromelt Furnaces, arc type.

* * * *

THE FITZGERALD MFG. COMPANY, Torrington, Conn.

"Star-Rite." Coffee Urn, Cat. Nos. 761, 751. Drink mixers with stand.

* * * *

THE KEYDEL COMPANY, 6564 Benson Street, Detroit, Mich.

Electric Christmas Tree Chimes Marking: "Keydel Co. 15 V."

SAVORY INC., 90 Alabama St., Buffalo, N.Y.

"Savory Airator," portable motor-driven fans.

* * * *

ERIE L. SHERK, Ridgeway, Ont.

Portable Air Heaters for automobiles. Marking: "Erie Engine Warmer and Utility Appliance," with rating.

* * * *

*AUTOCALL CO., THE, Shelby, Ohio.

"Autocall." Bells, Buzzers and Whistles, Types GP, H, N, R, RV, S, T, TV, TC. U. Autotone, Melotone.

* * * *

*GREAT NORTHERN MFG. CO., (Submittor), 536 Lake Shore Drive, Chicago, Ill.

Percolator, Cat. No. 2862; Toaster, Cat. No. 2701; Waffle Iron, Cat. No. 2705. Marking: Nameplate with trade name "Quality Brand" and rating attached to each device.

* * * *

*RADIO CORPORATION OF AMERICA, (Submittor), 233 Broadway, New York, N.Y.

CANADIAN GEBERAL ELECTRIC CO. 212 King St. W., Toronto, (Agent).

"Radiola 17" (Alternating current). Power-operated radio receiving set. 60 cycles.

* * * *

*WALLACE & CO., J. D., 134 S. California Ave., Chicago, Ill.

"Wallace" portable, electrically-driven circular wood saw. Marking:

Name and address of manufacturer; Model No. 5-RSC. Electric glue pot, portable Type W2. Marking: nameplate bearing manufacturer's name and address, type and rating of device.

Switches

W. H. BANFIELD & SONS, LIMITED, 370-386 Pape Ave., Toronto.

"Banfield".

Surface snap switches, rotary type; single-pole, Cat. Nos. 2000, 2047, 2602, 2604, 2001, 2048, 2753, 2754.

Three way, Cat. Nos. 2456, 2606.

Double-pole, Cat. Nos. 2392, 2394, 2608, 2610, 2017, 2050, 2763, 2764.

Flush Switches; single-pole, Cat. No. 2901 push type; tumbler type, Cat. No. 993.

Three-way, push type, Cat. No. 2903; tumbler type, Cat. No. 993.

Double-pole, push type, Cat. No. 2902; tumbler type, Cat. No. 992.

Fixture Switches, single-pole. Link switch, pull-chain type, Cat. No. 59. Conduit box and fixture switch, pull-chain type, Cat. Nos. 61, 615, 62 and 63.

* * * *

LANGLEY MANUFACTURING COMPANY, LTD., Granville sland, Vancouver, B.C.

Enclosed Switches, sheet metal cases.

* * * *

*ABSOLUTE CON-TAC-TOR CORPORATION, Elkhart, Ind.

Temperature Regulating Appliances (As listed on Underwriters' Laboratories card dated October 25, 1927.)

* * * *

*ARMSTRONG & WHITE, Pittsburgh, Pa.

Plug Fuse Cutout Bases. "A. W". Cat. Nos. 400, 1935, 2199, 2587, 2965, 2569, 7852.

* * * *

*AUTOCALL CO., THE, Shelby, Ohio.

Relays for use on signalling systems "Autocall." Type G1, single pole Type G2, double-pole; Type GP. Type O, Type S.

Paging system composed of central stations, relays and singlestroke bells or other sounding devices, Models 16A and 23, 23A and 25.

* * * *

*GAYNOR ELECTRIC CO. INC., Bridgeport, Conn.

Flush Switches. Toggle Type, single-pole, Cat. No. 502; Three-way Cat. No. 503.

Fittings

*ARMSTRONG & WHITE, 709 Renshaw Bldg., Pittsburgh, Pa.

Weatherproof, composition sockets, Cat. Nos. 60666 and 43310.

Weatherproof, porcelain sockets, Cat. No. 9366.

Fuseless Rosettes, "A. & W."

* * * *

*ADELL MFG. CO., THE, INC., Orange, Mass.

Outlet Boxes and Plates (As listed on Underwriters' Laboratories approval card, dated June 28, 1927.)

Miscellaneous

*NORTHERN ELECTRIC CO., LTD., 121 Shearer St., Montreal, Que.

Non-metallic sheathed cable. "Norel X." Marking: Two yellow threads together in inner braid.

* * * *

*These devices are under the Underwriters' Laboratories re-examination or Label Servics.

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Progress of Hydro-Electric Power Commission During 1927

By F. A. Gaby, Chief Engineer, H.E.P.C. of Ontario

(*Address before Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 19, 1927*)

I HAVE been asked by the President of the O.M.E.A. to say a few words this morning on the progress that has been made by the Hydro-Electric Power Commission in the past year in the growth of load of the municipalities, the number of municipalities under contract, the increase in the number of municipalities under contract and the financial position of the municipalities, and what progress has been made towards obtaining future supplies of power for the municipalities.

In view of the fact that the time is very short, I am not going to take up much of your time, but will content myself with a very brief statement as to the progress of the Commission during the past year.

With regard to the growth of load in the various systems operated by the Commission; the total load of all municipalities connected to the eight systems operated by the Commission was 1,050,000 horsepower, of which the Niagara System load exceeded 860,000 horsepower.

The net increase in load for 1927 amounted to over 75,000 horsepower, of which the Niagara System load increased by 66,000 horsepower.

The annual increase of load of the municipalities has met the anticipations of the Commission, with the exception of the Thunder Bay System, where there was a reduction in the load over 1926, due to the over production in the pulp and paper market. From present indications there is no

CONTENTS

Vol. XV **No. 3**

March, 1928

	Page
Progress of Hydro-Electric Power Commission of Ontario - - -	81
Public Service and the Psychology of Public Service - - - - -	85
Some Notes on the Law Relating to Public Utilities - - - - -	92

doubt that the position of the paper industry will improve in the near future and, when the market has overcome the over production in the paper mills, that this industry in the Thunder Bay district will improve its position and the loads anticipated will materialize.

The Hydro-Electric Power Commission on October 31st, 1927, served under contract 474 municipalities, in addition to which it served by arrangement 55 municipalities, making a total of 529 municipalities supplied by the Commission, including 25 cities, 83 towns, 210 villages and police villages and 211 townships, showing an increase of 48 municipalities over the year 1926, the greater portion of which were townships in which rural power districts had been established. In addition to the above mentioned municipalities, the Commission serves 91 power customers.

The total capital expenditure of the Commission and the municipalities to the end of 1926 amounted to $263,688,077.73, of which the investments of the Hydro-Electric Power Commission were $203,071,456.78 and the municipalities $60,616,620.95. (The amount of $263,688,077.73 includes $9,389,899.60 for railways).

During the fiscal year 1927 the increase in capital expenditure amounted to, as far as the Commission was concerned, $3,290,026 and the municipalities approximately $3,950,000 making a total of $7,240,026.

It is to be noted here that the capital expenditures of the Commission, compared to former years, have not been very great during the year 1927, and of the total amount of $4,021,026 expended, over $1,462,000 has been expended on the extension of lines into rural districts, leaving $2,559,000 for increased development and the necessary transmission lines to serve the municipalities in Ontario.

During the year 1927 the Hydro-Electric Power Commission handed back to the City of Toronto the assets of the Toronto and York Radial Railways, reducing its capital expenditure by $3,500,000, making a net capital expenditure at the end of the year approximating $203,692,780.

The financial position of the Commission and the municipalities is steadily improving, and at the end of this fiscal year there was some $64,000,000 in reserves, of which amount the Commission had accumulated $29,000,000, the balance being in the hands of the municipalities, with an annual increase of from $8,000,000 to $9,000,000.

In the case of the Hydro-Electric Power Commission these reserves are liquid, and are held for depreciation, contingencies and obsolescence and for sinking fund necessary to retire

the debts that had been incurred on the properties of the Commission.

For a number of years there has been a great deal of agitation in the Eastern districts for additional supplies of cheap power, the criticism being that the Western part of the Province was receiving more favourable terms than the East in regard to power supplies and the rates to its consumers.

In order to meet the needs of the Eastern parts of the Province the Commission during the past year and a half or two years has been actively engaged in negotiations with various corporations for additional supplies of power for Eastern Ontario and Central Ontario system needs, pending the development of the St. Lawrence and Ottawa powers, which, I do not need to tell you, have been delayed, owing to the many interests that are involved in the development of these water powers.

After receiving during the Fall of 1927 definite propositions from those corporations capable of delivering the power required by the Commission, it was decided to accept the contract of the Gatineau Power Company for delivery of 100,000 horsepower from its developments on the Gatineau River for delivery to points in Eastern Ontario.

It is a very favourable contract to the municipalities, in that it provides for a minimum of 6,000 horsepower per annum for the first ten years, with an option of the municipalities to take 100,000 horsepower, when needed, during that period, upon proper and reasonable notice.

The rates for delivery of such power, which is estimated at approximately 25 per cent., to the Western boundary of the City of Ottawa, is $15 per horsepower per annum at 110,000 volts and for the remainder of the power delivered to Smiths Falls at 110,000 volts $14.70 per horsepower.

This power will be supplied to the Ottawa, Rideau, St. Lawrence and Central Ontario districts, and the first delivery will be made in October, 1928.

The entering into of this contract means that for the period of ten years, pending the development of the St. Lawrence and Ottawa powers, that the Eastern municipalities can obtain power at costs that are equal to the costs existing in the Western part of the Province, and more especially in the Rideau district, the cost of power will be very much reduced over the cost existing at the present time, as the loads in this district increase, and with regard to the Central Ontario System delivery of its power, in conjunction with the present generating cost at 44,000 volts, will not materially increase the cost to the municipalities, and as their load increases it will tend to decrease the present cost at 44,000 volts in the loop system, so that, taking the contract as a whole, it is of great benefit to the districts in which the power will be delivered, enabling them to meet their needs, and supply new industries, without any increase in rates over those in existence at the present time, and, in some cases, reductions.

At your last annual meeting the Commission informed you that it had

entered into a contract for the delivery of 260,000 horsepower to the municipalities in the Niagara district; during the year 1927, considerable progress has been made in the construction of the necessary lines to deliver this power in October, 1928.

It was originally estimated that the 200 miles of transmission line and the transformer stations at Leaside, including synchronous condensers, would cost, for delivery of the full amount of power, between $14,000,000 and $15,000,000, which expenditure will be extended over a period of from four to five years.

Since August last, when the Commission received first delivery of the necessary steel, which it had contracted for in May or June of 1927, the Commission has constructed 89 miles of footings, including back fill, erected some 79 miles of towers and has strung some 3 miles of cable, in addition to which some 70 miles of roads have been built through very rough country to facilitate the construction of this transmission line and to maintain same in the future.

It is the purpose of the Commission during the winter to continue such work as it is possible to do economically during the winter months, in the installation of rock footings and the stringing of cable.

Good progress is being made at the present time on the manufacture of the necessary equipment to be installed at Leaside, and operations have been commenced on this site for the erection of buildings for the installation of such equipment.

The station at Leaside will be of the outdoor type, the buildings being a minimum and only erected for the maintenance of equipment and the housing of control and metering apparatus.

During the year 1927 there has been a remarkable increase in the extension of electric service to rural districts, which shows that there is a better understanding of the cost to rural communities, and the people are beginning to appreciate the service that is being rendered by the Hydro-Electric Power Commission to these communities.

During the year 1927 the Commission built over 875 miles in rural districts to serve some 5,700 consumers, with a total to the end of October of 3,200 miles of rural lines constructed, serving in the neighborhood of 25,000 consumers, at a capital expenditure of $6,700,000, of which $3,500,000 was received from the Government as a grant towards the capital expenditure on these rural lines.

It is estimated by the Commission that for the year 1928 rural extensions will be made to the extent of 1,050 miles to serve from 4,000 to 5,000 consumers, with an additional capital expenditure of $2,600,000.

This demonstrates the very rapid progress that has been made in the extension of electric services to the rural districts by the Hydro-Electric Power Commission, and no doubt answers the criticism that has been levelled at the Commission and the municipalities that the cost to rural communities is high.

Surveying the progress of the last year, the Commission and the municipalities should be gratified to know

that their expectations have been met in the growth of load and in the obtaining of additional supplies of power to meet future needs.

I have also been asked to say a few words as to the progress being made by the Commission in meeting the request of your Pension Committee in the establishment of a Pension and Insurance Fund.

The Commission has received the reports of your Committee and has given same careful consideration, but before finally passing on the reports to the Government, with application for Order-in-Council, it is acting on the advice of the Legal Department in obtaining detailed calculations as to benefits received by individuals and illustrations of the cost of such scheme to the municipalities, so that the Government will have before it full information in order that it may give an early decision as to the issuing of the necessary Order-in-Council authorizing the Commission to enter into the necessary contracts with the Insurance Corporations.

This matter is proceeding as rapidly as it possibly can at this time and we expect that there will be an early decision in connection with same.

I wish to thank you for having had the opportunity of presenting these few matters to you, and I have endeavoured to be brief, as I understand that you are to hear a report from the Pension Committee on the progress of their investigations in connection with the Pension and Insurance Fund.

Public Service and the Psychology of Public Service

By Stewart Lyon, Former Editor, The Globe, Toronto.

(*Address before Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 19, 1928*)

WHAT I want to speak about this afternoon very briefly is the question of public service, and the psychology of public service, the question as to how men approach the idea of serving people, and what we actually get from that method. I knew Sir Adam Beck very well, and the thing about Sir Adam that struck me most was his directness of mental attitude, toward all the questions that he tackled. Whatever got in the way, had a hard time, because Sir Adam occasionally used the mailed fist and hob-nailed boot and a lot of other things, but he never used them except as he believed the public good demanded that they should be used.

I have always said that it required a man like Beck to meet and compete with men like MacKenzie. Wolf against wolf, let us say. Sir Adam had this about his mental make-up that, when it came to a decision that a thing was in the public interest, he

would sacrifice his best personal friends rather than turn aside from the duty that he felt he owed to the public, and that is a very great quality. I sometimes hear people say, "Oh, he is a fine fellow; he stands by his friends." Well, it is a good principle to stand by one's friends, but it is a much finer thing to stand by one's principles and one's ideals. That, I think, is something that we need in public service and to have preached to us more and more; that personal friendships shall not count as against the public interest.

I know another public service chief in Canada who also had certain very fixed ideas, as to the animating motive of public service, and the method of getting that motive across into action. When Sir Henry Thornton first came to Canada, he learned that we had been advocating very steadily the amalgamation of the Canadian Northern and the Grand Trunk and the forming of a unified National Railway System. I knew nothing of him until he came to me and said, "I have heard of your paper's attitude, and I should like to have a talk with you to explain what I mean to do in Canada." Then, he went on to tell me that, in the management of the Great Eastern Railway in England after the war—you know that he became a Major-General in France, was knighted for his services in running war railways and after that went back to England—he found that the Great Eastern Railway was in a pretty disorganized condition, probably due to war conditions, and that the men who had temporarily taken hold of that institution were too far from the operatives of the road. Sir Henry told me that, for almost two years afterwards, he went up and down the road attending meetings of the enginemen and the firemen, and all the other organizations, and got so that he could call a very large number of the employees of that road by name. The result of his efforts was, that before he left England, the railway of which he was head was one of the most economically and carefully operated railways in the country, and its net earnings had materially increased. He told me, at that first meeting, that he had come to Canada to bring about the amalgamation of two utterly hostile railway operating staffs, and many of you know how keen the jealousy was at that time between the Canadian Northern and the Grand Trunk staffs. He told me he was intending to bring those two factions together into a more closely-knit association, so that they should play the team work and they should forget they were Grand Trunk men or Canadian Northern men and remember only that they were men who were proposing to put the Canadian National Railway on the map. He said, "I shall seem to neglect the most important things in my occupation; the strengthening of bridges, the increasing of locomotive power, improvement in the tonnage per train carrying. I shall seem to neglect those things until I get an organization that will recognize itself as a unit playing for the team, rather than for the individual man." Now that was the thing that Thornton came to Canada to do, feeling that, in public service, that kind of team play was more vital

even than the most regular equipment, and the best system of operation. In all sorts of business and in your business more especially, where you come directly into contact with people, the personal equation more and more counts. Let me give you one story about Thornton's method of bringing that about. The Honourable "Tom" Crerar came into my office one day, and he said, "I was coming east from Rupert the other day, when an old negro porter on the train came up to me, and presented to me a frayed looking letter and said, 'Look at this, Mr. Crerar'." He said, "I looked at it, and it was a letter from Sir Henry Thornton, written by his own hand, in which he said, 'You have been very kind to two English ladies who came from Rupert to Edmonton in your charge, as Pullman Porter, and I want, as the head of the Canadian National Railways, to tell you I personally appreciate that kindness and that I want to see as many employees of the road as possible give it so as to earn the same praise I give to you'." Now that porter made thousands of converts to public operation just by showing that word of praise in season, a word of praise from a man who commands an industrial army of 85,000 men, and who thought that porter was worth singling out. Do not forget that molasses is a very much better flycatcher than vinegar.

I had on my desk at one time, an old Japanese proverb that I thought might be useful. It ran thus: "I have had many troubles, most of which never happened." A lot of you have had troubles which were entirely troubles of the mind, which could be wiped off the slate by a change in the mental attitude. Now, I think the most important thing in the development of Ontario's Hydro System, and in retaining the goodwill of the people is the mental attitude of the men who are in charge of the institution. When I was asked to say a word or two on public service, I went out, as I sometimes do, and "Put my ear to the ground." I talked to five people about the reaction in their own minds of public service conditions. One was a County Councillor, who had to do with the awarding of road contracts; another was a road superintendent; the third was a meter inspector. The fourth was a Scotchman from Stirling, and the other an Englishman, an Engineer in one of the Hydro Systems. I asked these men, "How do you feel serving the public, rather than the private employer?" Mr. E. W. Beatty says that one cannot have the same feeling serving a public employer that you have serving the private employer; that the capital has to be put up by private individuals, so you don't have any sense of loyalty to the institution." It is a peculiar point of view, and I wanted to know what these men thought of it who were all working in public service. The philosophical Scotchman from Stirling said: "You know, since I became an employee of the public, I have tried to give better service than I did under the old order and conditions, and for this reason—my employers in the last analysis are the public, the people I go to see, whose meters I attend to, and all that sort of thing. They are the stockholders of the Company. I want to prove to the stockholders of

the Company that we are doing an efficient service for them. I want to give them the best that is in me, do my work sufficiently well, and make the stockholders of the Company satisfied with the condition in which the plant is operated." I asked the Englishman, who was also engaged in a similar business, what he thought. You know it is sometimes said, these English Trades Unions are "ca'canny" and that they shirk. I wanted to find out whether they shirked more under a public operation boss than a private operation boss, and I said: "What is your re-action when you go out on the job? Do you want to shirk? Do you feel you want to shirk a little more, that you can let the public down a little more than you can let the private individual down?" "There is not a bit of difference in my mind. I feel more inclined to serve that public Superintendent than if he was a private Superintendent of a Company." Then I went to the Engineer who was an old and grey-headed. "Yes, I do feel a little different," he said. "In the old days, some of the men who were over us were much better men than the men who are over us now." "Technically" I said. "No", he said; "in the way of plain, common honesty." I am giving you the reaction of a man that is not negligible, because he represents a considerable class. He said, "In my own case, I had an experience recently with a man who was putting in time sheets in the loosest possible way and giving some of the employees, with whom I am acquainted, more wages than they ought to have had." I said, "Is he? That is a corrupt transaction." "Oh, no," he said, "just carelessness; just letting the men get away with it." Now, that is a matter that is not necessarily the fault of public operation. But what I am getting at is the reaction that is in the minds of the rest of the staff. Have these working men got to think that supervision is less strict, under public operation, than under the keen hand of a private owner? It won't be good for your systems; it won't be good for Ontario; it won't be good for public operation. I think probably the case may have been singular—I hope it was. You gentlemen before me know, in a way that no man outside the Organization can know, whether it was singular or not. If it was not singular, if there has been a disposition, on the part of the Manager, to screen a bit because the employer was the public instead of a private individual, I would beg of you to take very great care that your workmen shall not be able to say that favouritism of that sort had been creeping into the operation of the system. The Road Superintendent told me that he found this:—That a man having irregular labour relations with a public service corporation, or with a municipal corporation, had, at the back of his mind, something of the idea that we used to associate with the old dogma, in certain sections of the community in this country. That if you robbed the private employer or the private individual, that was theft, but, if you had the same transaction with the public till, that was lifting something; the old idea of the Highland cattle trader, that it is robbery, if you take it from a private

individual, but, if you take it from that thing called the public, that you don't know anything about, it is not theft at all. And he said that he had cases where men would put in bills, for road repairs that, unless they were checked up, were quite dishonest. He said: "They would put in these bills, I am perfectly certain, because they think that the public is better able to stand it and will stand it better than the private employer." There is a case of the psychology of the thing that one has to watch. Not only the employer, but the contractor, and the person who is doing business with you, if he thinks you are slack enough to stand for it, will regard the public as an easier mark than the Company which employs people directly under private capital. I think it must have been because of little things like that, that Mr. Beatty took the ground that supervision, on the part of the private employer, was keener than on the part of the public employer, and that, therefore, things were permitted in the public service that would not be permitted in private service. I must say, on the whole, I disagree with him. I would take the ground, rather, of the Scotch philosopher who says that he would serve the public with a better conscience and of the Englishman who said that he would be less disposed to be canny in public service than in private employ.

Now, a word or two as to the environment in which this public service is being done in Ontario at the present time. Last Spring and Summer, during the flood in the Central Valley of North America, I crossed the Mississippi, the Missouri, the Red, and the Arkansas Rivers, twice during the flood period. There is no comparison between the environment in which public service, which is in a pretty primitive condition out in the mid-west, is being carried on there and in Ontario. Here in Ontario, you men in the electrical business have the greatest millponds in the world at your disposal. They will be there for all time. You are digging most of your huge works in the living rock. One sees, in the Roman plains, viaducts and waterways that were built on stilts by the old Romans two thousand years ago. When these things crumble into the dust, you will still have things like the Niagara power generation and the other works which you are building on an everlasting basis. Not only will you have permanent works of that sort to work with, but you will have a permanent supply of raw material. The people engaged in almost every other kind of business that I know anything about are continually worrying about raw material. Is it going to hold out? Will we have to move our factory nearer the source of our raw material? Will the cost be so great that our competitors will have to do that? As long as the sun shines and water flows, the raw material with which you are going to operate will last. Now, that is a tremendous thing. Not only so, but you have tremendous advantages in the matter of capital, as compared with the privately owned institution. I suppose you saw that the Shawinigan people had bought out the privately held shares of the St. Maurice, which had really been a subsidiary for

some time, and for those shares, they are going to pay $12,500,000. Beneath these shares there are underlying bonds of $9,000,000 and debentures of $1,000,000, so that the capital of St. Maurice, as calculated by the Shawinigan people will amount to about $22,500,000, and for that they get the present development of 120,000 h.p. and the possibility of an additional 30,000 generator; but they are paying, in round cash, $22,500,000 for 120,000 h.p. capacity. Now, what will be the result of that payment on the future capitalization of electric power in the area served by Shawinigan, and by the old St. Maurice? In a little less than thirty years they will have paid off ten million dollars, which must all come, of course, from the consumers of power, and there will remain on the books of the Shawinigan Company, and remain, I fancy, for all time, an amount of $12,500,000 which represents, not a capital investment at all, but bonus stock which was originally of no value, and the value of which has been created and maintained by the users of power. For all time that 120,000 h.p. of Shawinigan will be burdened with interest of about $750,000 yearly to pay the dividends on stock that originally had no value whatsoever, and the value of which will have been created by the people who pay for the property. Now, contrast that capital condition with the capital condition of the industry with which you are connected and engaged. Let us see what you are doing. I have often said that we are taking a little too much from the future, that we are taking away a load too much from the future, because, speaking generally, in thirty years, after the commencement of the sinking fund on your powers, all of the capital involved in the construction of these industries will be wiped off, and you will, in addition, have accumulated moneys for replacement and renewals sufficient to keep the plants in good order, and you will hand over these various Hydro plants in Ontario, free of debt to the coming generation, and they will be able to carry on their business without capital charges. There will be no stock or bonds; they will have been paid off; and there will be no interest payments. These will be only the cost of operating Hydro for the generation that begins about 1940 or 1945, plus renewals and replacements.

It has been said that the rates may be getting a little too low, and that, because of the greatly encouraged use of power that the power won't be available in sufficient volume. What will it be thirty years from now, because there is nothing else to which we can apply the money? It will be all available for the payment of operating cost only and replacement to the existing plant, because I assume that these replacement moneys will keep the plants in good operation, and that you will not be required to go into any great capital cost. So looking to the future, and comparing your power situation in Ontario with that of a private corporation in Canada or the United States, from a capital point of view. I would think that in less than thirty years from now there would be no possibility of competition on the part of private companies in the matter of price with the power

that may be obtained in the Province of Ontario. The rush of all sorts of uses for Hydro will then come in a way that you young fellows, who will be grey-headed then, do not understand at the present time.

Not only is this matter of environment important, but the possibility of beneficial development in the future is, I think, very critical. I do not think there is any doubt that you will get St. Lawrence power. Within the next twenty years you will have throughout the Province of Ontario, probably two and a half million h.p. developed. What are you going to do with it? While you get the factories, the shops and the workshops, you get the great uses in the homes. I would like to see the Electrical Association of this Province try to develop the use of Hydro to rehabilitate the social life of rural Ontario.

Most of us think in the terms of a town, with its fine houses, its excellent sanitation, and all the conveniences that man may desire. But I am kind of a farmer, and Hydro power is not yet along the road between Fergus and Orangeville, and I would like to see it come. When it comes, I want to see that power used, not so much to help a man split wood and make chop and do a man's job on the farm, but to give the woman of rural Ontario a chance. Have you ever considered what the condition of sanitation on the farm means at the present time, conditions that are primitive, to say the least, and conditions that, I believe, drive every year thousands of young girls to the cities so that they may get better household conditions. I would like to see your Provincial Hydro Commission evolve some system under which you can go into these farm houses and advise sanitation equipment for the farms the same as you are now doing for power on the farm, and work for the women of rural Ontario as well as the men. Why shouldn't you say they can put in an outfit with hot and cold water, with bath, and all other conveniences that we are quite accustomed to in the cities. I would suggest that you install a unit of that sort, and give time to pay for it, just as you repay the capital cost of your share of building the Hydro lines in the country at the present time. I believe that you could get tens of thousands of farmers who have failed to install sanitary appliances because, at the present time, it means placing the work in the hands of a plumber in a town, and having a man driving out miles every day to put it in. But, if you were to say, "we have a pumping outfit we will let you have, the wiring is at your farm door, we will put in a septic tank, and provide you with a bath and closet, and we will do that as part of the development of the Hydro system of this country, partly because we want you to use our power but partly because we want to lessen the drift from the country to the city, and we are maintaining in certain parts of Ontario a progressive population to build up the manhood and the wealth of the Province," I think the thing can be done. It may be the kind of dream Adam Beck used to have; it may be a pipe dream, but you know some of these pipe dreams do come true. I am just hoping that you younger fellows, many of whom

have twenty or thirty years in public service before you, will try to think that the greatest benefit that you can do to this Province at the present time is to anchor the population upon the farm and especially to provide facilities by which the women of the farm will participate in the benefits of the extension of Hydro.

In closing, I desire merely to say, that it has been a great inspiration to me practically all my working life to be associated with men like Sir Adam, Mr. Maguire, and Mr. Ellis, the veteran of all of you, in bringing before the people of Ontario something of the benefits that accrued from unselfish public service. I think there is sufficient idealism among our people to carry on the work that these leaders have begun, and I think it quite possible that, with the development hereafter on the scientific side of electrical transmission and generation, and with the great increase in wealth and population that this Province is bound to have, it would be quite possible to separate and spread the bounds of the benefit of Hydro much wider than ever they have been before.

Some Notes on the Law Relating to Public Utilities

By W. G. Hanna, Legal Dept., H.E.P.C. of Ontario

(Read before Association of Municipal Electrical Utilities at Toronto, January 19, 1928)

THE modern method of dealing with a subject like this is called the case method. I am afraid it will be difficult to make the subject interesting. The number of cases will prove dry, but I hope not altogether empty.

In the first place I would like to remind every member here that the Public Utilities Act can now be found in the New Revised Statutes which came into effect on the 31st. December, 1927, and which will be much more convenient, because the law, up to date, will be comprised pretty completely in the one Statute. It will be found in chapter 249 of the New Revised Statutes. Turn to the Act and open at Part II and you will find just as in the old Act, it commences with a definition of a "Public Utility. Section 16 defines it as artificial and natural gas, electric power or energy, steam and hot water." The next section in Part II, Section 17 provides the charter of authority for municipalities, as follows: "Every urban municipality may manufacture, procure, produce and supply, for its own use and the use of the inhabitants, any public utility for any purpose for which the same may be used." It then goes on to detail the necessary incidental powers.

The first case I wish to refer to is the case of the Ottawa Electric Railway and the City of Ottawa. Electric Commissioners were established for the City of Ottawa under a special

Act. This was prior to our present Public Utilities Act. As the Statute stood at that time, a Public Utility was empowered to manufacture, produce and supply, not procure. What the City of Ottawa proposed to do was to buy a supply from the Ottawa and Hull Power Company. The Ottawa Electric Light Company took proceedings to stop them, and judgment was given in favour of the Electric Light Company. As a result the Statute was changed, and municipalities were given the power to procure, as well as produce.

After a Utility is established, it is carried on sometimes and particularly in the initial stages, by the municipality itself, by a committee of council; but in most instances, it has been found much more convenient to have it carried on by a separate body, a Utilities Commission. In fact, under The Power Commission Act, it is compulsory to have a Public Utility Commission in cities and towns which have contracts with the Hydro-Electric Power Commission. The establishment of these Public Utility Commissions goes back a long time. A brief glance at some of the early history will be valuable if we are to understand the exact relation of the Public Utility Commission to the Municipal Corporation. When Utility Commissions were first tried as in Toronto, about the year 1874, there were two cases which throw light on the relationship, one in Toronto and one in Windsor. Ridgeway vs the City of Toronto is a case in 1878, under the special Act in force at that time, setting up the Waterworks Commission. In this case the Waterworks Commissioners were held to be merely the Statutory Agents of the municipality, and to some extent, servants of the municipality. That Special Act was very different from the present, because it expressly provided that the Commissioners shall carry on their functions as agents of the municipality. Their powers were much more limited than at present. Therefore Ridgeway succeeded in obtaining judgment against the City of Toronto, and not against the Commissioners. His claim was for damages, because the Waterworks Commissioners, in making an excavation, had not replaced the earth in a satisfactory manner, and a fall-in occurred alongside the highway.

Another case in Windsor, under a similar special Act involves the same principle of statutory agency, but the facts are a little different. Perhaps you know the situation in the Border Cities—Windsor, Walkerville and Sandwich. They found it necessary ultimately to organize the Essex Border Utilities Commission to handle their affairs because they were not able to get the councils to work together. The City of Windsor had to draw its water supply out of the Detroit River within its own bounds —that is, downstream from Walkerville. Walkerville dumped its sewage into the Detroit River, upstream from Windsor. The people of Windsor thought it would not be a bad idea if they filtered a little bit of that out. The Windsor Waterworks Commissioners, under their powers, were to establish these filters, but there was only a certain fund provided, of which there was only $18,000 left,

and the contract was $40,000 over two years. They tried to split up the $40,000 and suit was entered against the Water Commissioners. It was held that they had no power to proceed as they were doing, because they were only the Agents of the Council and should have had a by-law of Council before they entered on the work. The case turned on two points, (1) the money was not there, (2) the Commissioners were only Agents of the Municipality, and had to get a by-law before they could start the work.

The old Waterworks Act and Heat, Light and Power Acts were combined by the late Provincial Secretary in Sir James Whitney's Cabinet about 1912, and made the Public Utilities Act. In a recent case of Toronto Electric Commissioners and Toronto Electric Railway in the City of Toronto, under the Public Utilities Act, the Honourable Mr. Justice Riddell expressed the opinion that the Toronto Electric Commissioners were not the Agents of the Municipality. "It is fair to say that the Commissioners repudiate the position of Statutory Agents and I think successfully distinguish the previous cases."

The next case is Young vs Town of Gravenhurst which is interesting from two points of view, to establish the relations of the Commission and also the question of negligence. This was the case of a boy lying on a bed with an iron bedstead in contact with the radiator and, through defective construction, high voltage leaked through the service into the house, got into the hot water system, passed through the bed and burned the boy. The Town of Gravenhurst was sued. The late James Bicknell, K.C., argued in that case that the Town, as a Corporation, consists of the inhabitants and is a distinct body from the Council. The powers of the Corporation would be ordinarily exercised, not by the Council but another body, the Commission; the liability of the Corporation is the same whether its powers are exercised by the Council or the Commission. The late Chief Justice Moss, Chief Justice of Ontario says, "It is not disputed that the system is a municipal system. The argument is that, because the defendants availed themselves of the provisions enabling them to take control and management of this portion of their property from the Council and entrust it to other hands, they are not to be liable as they would be if the management and control remained in the Council. Statutory enactments furnish no real support for this argument. Under the Municipal Light & Heat Act—that is the old Act—it is the Corporation which has to construct, maintain and conduct its business. The Board of Commissioners, when constituted and elected, is the body which assumes not the ownership, but the management and conduct of the works very much in the same way as the Council Acts for the Corporation under the Municipal Act." Mr. Justice Garrow said that the objection taken by the defendants, that the Board of Commissioners was the proper body to sue, was properly overruled. It was held that the Board was merely Statutory Agent to carry out for the defendants

the object which the Legislature had placed under its management and control.

Those two words, "control" and "management" run through the legislation; but there is this marked distinction between the legislation on which Young & Gravenhurst was decided, and the present Act. The Revised Statutes of 1897, Section 40, which is equivalent to 36 in the new Public Utilities Act, and 35 in the one just displaced, reads as follows: "The Council of the Municipality may itself exercise and enjoy the powers, rights, authorities and immunities hereby conferred upon the Corporation, or such Council may, by by-law, assented to by the electors, provide for the election of Commissioners, and upon the election of Commissioners, all powers, rights, authorities and immunities which, under this Act, might have been exercised or enjoyed by the Council, and the Officers of the Corporation acting for the Corporation, shall and may be exercised by the Commissioners, and the Officers, appointed by the Commissioners, and the Council thenceforth, during the continuance of the Commissioners, shall have no authority in respect of such works." That old Act of 1897 simply puts the Commission in place of the Council. Since the Public Utilities Act was first passed and certainly since 1914—when it appeared substantially in its present form, the wording has been different. The present wording is as follows: "Upon the election of the Commission, as hereinafter provided, all the powers, rights, authorities and privileges are, by this Act, conferred on the Corporation, shall, while such by-law remains in force, be exercised by the Commission, and not by the Council of the Corporation."

Please note, it is not the rights, authorities and privileges of the Council, but of the Corporation which are to be exercised by the Commission, instead of the Council. That puts the Council out of it altogether and they cannot interfere. Strong ground was taken in a fairly recent case in 1925, one which has some rather peculiar turns to it, namely, the Campbell Flour Mills and the City of Peterboro. Complaint was made that the Campbell Flour Mills were not paying their fair share in rates for the power received. This had been investigated twice; once by the local Utilities Commission, and a second time by the H.E.P.C., and both times it had been decided that the meters were correct, and the billing was correct. One of the aldermen urging this third investigation was also engaged in the Flour Milling business. A subpoena to produce documents was served which was obviously intended to reach the business records of Campbell Flour Mills. I think that would be sufficient to indicate that there probably was some local colour in the case.

Mr. Justice Hodgins stated the sole point involved was:

"What is the right of the Corporation to institute an enquiry before the County Court Judge under the Consolidated Municipal Act, in a matter which, under certain legislation, is not under direct control of Council, but is handed over to another body to manage. That Section,

namely Section 248, provides that the County Court Judge shall make an enquiry when the Council pass a resolution, requesting him to investigate any matter relating to supposed malfeasance or breach of trust, or to enquire into any matter concerning the good government of any municipality."

The very widest language is used, and certainly one would think, that the proper conduct of an Electrical Utility would be included in the good government of the municipality.

It was urged that, since Peterboro City is entitled to any surplus that the business must be that of the City, and, therefore, within the required Section of the Municipal Act. This ignores the object of setting up an authority different from the Council, which, under the Statute, represents the people of the municipality and is elected by and responsible to the same constitutuency. It must be clear to everyone that the Legislature has, from time to time, vested, in independently elected or appointed bodies, various parts of what was originally the business of the municipality, (such as for illustration Public Utilities, Boards of Health, Police Commissions and also Boards of Education). In particular, the management and control of electrical energy has generally been placed in the hands of a local Commission, on account of its technical character.

Mr. Justice Hodgins then proceeded to trace the history of the legislation through the Acts of 1887 and 1897. He pointed out that the authorities and powers conferred on a Public Utility, are those of control and management, and does not say anything about ownership. The Corporation of Peterboro represents the inhabitants, but only so far as the Legislature consents to the business of those inhabitants being so represented, and not where they are, as to the supply and distribution of electrical energy, represented directly, by force of special legislation, by the Public Utilities Commissions. There is no power, save that of the Legislature, to divert from the Peterboro Commission, the power and authority given it by the legislation I have outlined."

In another case, on a similar investigation namely, Berlin vs. County Judge of Waterloo, Mr. Justice Middleton, deals with the same issue. He points out that Section 248 is very wide including as it does, investigation into anything concerning the good government of the municipality and some limitation must necessarily be found to the wide terms used. "No one supposes, he says, that this confers unlimited jurisdiction on the Council. I don't think it is competent for a Municipal Council to direct an enquiry before the County Court Judge into matters entrusted to these independent bodies." Mr. Justice Middleton in essence, says that in all matters entrusted to these independent bodies within the limits of their jurisdiction, they are in no sense subordinate to the Municipal Council. This has been demonstrated in a number of cases where the Council has undertaken to review the action of School Boards as in Simpson and the Local Board of Health of Belleville.

An analogy may be taken from the case of a person named as "persona designata." This will be seen in the case of Cummings vs. York Township, where the Treasurer of the Municipality is specially named under the Assessment Act, and therefore he personally is liable, and not the Municipality, for his acts and for the cost of advertising a tax sale, because he has acted not as Treasurer of the Municipality, but as a person specially named under the Assessment Act. The party who sues the municipality for that advertisement is out of luck, because the Treasurer is the one responsible under the Assessment Act, being especially named. The analogy may be applied as follows: The Utilities Commission having been established by special legislation is independent of the Council and directly represents the Corporation, being specially named in the Public Utilities Act.

How far does that representation go? I don't think it goes to ownership. So far as I have been able to ascertain from enquiries, practice varies a great deal. In the great majority of places, the land is in the name of the municipality, and is occupied by the Utilities. There are good reasons for that. One very practical reason is that under the Public Utilities Act by which the Commission was created, there is also power to abolish the Commission. If the land were in the name of the Commission when it was abolished, mistakes might occur. If the land is in the name of the municipality, the Commission represents the municipality, and has the use of that land and where the Commission is abolished, the land is still there for use in the name of the municipality.

The next question is the question of the liability of the Public Utilities Commission to be sued. The Act states that the Commission shall be a body corporate. In the eyes of the law, there are three forms of personality recognized; there is, the individual; there is the partnership in which each member is personally liable to the full limit of all the debts, and there is the limited liability of the Corporation which is recognized as a distinct personality. Within its charter powers, the Corporation is able to carry on as an individual. The charter powers of the Public Utilities Commission are to be found in the Public Utilities Act. It is a corporate body. Therefore, it is entitled to sue and is liable to be sued.

Being a corporate body, it should have a seal. This may be somewhat of a new thing to some. I believe some of the Utilities Commissions have seals but a number have not. A body corporate speaks by its seal and every Public Utility Commission and Hydro Electric Commission should execute documents under its seal. This is different from Telephone Commissioners because, in the Telephone Act, while there are full provisions for appointing Commissioners and for their powers and duties the Act does not say the Commissioners are a corporate body. A Public Utility Commission, being a corporate body, can only express its individual action by its Corporate Seal, attested by the signature of its various officers who, in so attesting,

really act as witnesses to show that the seal was put on the document by proper authority. The cases dealing with trading companies go so far as to say that the corporate seal on a document is *prima facie* evidence of proper execution. The seal itself is the evidence of the Corporate action of the Public Utility Commission.

The Commission, as a corporate body is entitled to sue and is liable to be sued. I am certain there is not a Public Utility Commission represented here to-day which would want to give up its right to sue; sometimes that is necessary for such matters as arrears. The threat of being able to start an action is very useful.

On the subject of liability to be sued, some useful information may be gleaned from cases in which other public bodies were involved. Defences have been set up that such bodies had no funds of their own; they were only administering public funds, mainly charitable, and therefore could not be sued, because, if you took judgment against them, you could not touch these funds. This is what is known as the trust fund theory, which was fully developed in England some years ago and finally overthrown. There was a case in Ontario, Lavere vs. Smiths Falls Public Hospital, 35 O.L.R., in which the trust fund theory was advanced. Mrs. Lavere, after a doctor's recommendation, went into the Smiths Falls Hospital for an operation. After the operation, when she came to, she was rather severely burned, and suit was entered against the Hospital. There were two defences. One was that the nurse who had charge after the operation was not a servant of the Hospital, but of the surgeon, and the other, that the Hospital had no funds to meet the judgment. Both were decided against the Hospital. It is the second only that we are interested in. In the judgment, previous cases are very carefully reviewed. Liability in the Smiths Falls case was established in spite of the respondent's claim to exemption from liability on the ground that it was a Government Agency carrying on work not for profit, but for the benefit of the residents of the district. In the words of one of the judges on appeal: "I agree with my brothers in the rejection of this claim, because it is now recognized that a public body is liable for negligence of its servants in the same way that a private individual would be liable in similar circumstances, notwithstanding this Act, in the performance of a public work like a public hospital."

There is a Toronto case, Everton and Western Hospital—to digress for a moment—a pneumonia patient was given a bed on the top floor of that Hospital, a very careful nurse in charge, the patient was very safely esconsed in bed, the nurse had some duty that took her to the corridor for a moment or two to make some report or notation on a history sheet, when she came back she found the window was open and the patient was departing head first. She went to the window, grabbed him by the nightshirt, but the hospital linen gave way or she lost her hold and he escaped through the window, fell to the ground and was killed. The family brought action, and the case

never went beyond trial, because the judgment was a small amount, and they paid the judgment, rather than carry it any further.

To carry further the question of liability, I may use another illustration from municipal law that may prove of interest. It is found in the case of the City of St. John vs Donald. The complainant sued for damages for injury to his house, caused by an explosion of dynamite, stored by the defendant Moses in a shack nearby. A short time before the explosion occurred, Moses had caused a quantity of forty pounds of dynamite to be placed in a shack, immediately adjoining the street, which he had erected for a tool house and which also contained a forge for a blacksmith. Some of the contentions are interesting. First it was contended that Moses was not the servant of the City but an independent contractor. On the other hand the plaintiff contended that Moses was a servant of the city, not an independent contractor, and also that, even if he were an independent contractor, the city was liable because the work was such that, in the natural course, injurious results were to be expected, and they ought to take extra care. Both these issues were decided against the City of St. John. The first claim that he was a servant and not an independent contractor is very interesting. He was acting under an engineering contract. He was a contractor, but the City Engineer had so much control over his work, and his manner of doing it, that he was not independent, and that was the touchstone. It is worth remembering. An independent contractor may be employed to do work, but if he is interfered with in his manner of doing it, so that the city or the city's employee direct him in his manner of doing that work, the city is liable for all the consequences because he is the servant of the city.

On the second issue of the liability of the city in any event, whether he was a servant or not, it was decided that, if the city had to do a dangerous thing, they owed a duty to the public and they could not get rid of it by employing somebody else to do it for them. That comes pretty close to home, because electric utilities sometimes have to construct works and danger may occur some time during the construction, or electric works for some unexpected causes may become dangerous. It is not always possible to take refuge behind the claim that someone else was employed to do the work. If you are a public body, and that danger is so obvious, a duty is cast upon you to see the public is not injured. The palpable recklessness of Moses, in putting dynamite in a building occupied as a tool house and used as a forge, involved the city in responsibility.

After the question of liability which arises from the status of the Commission as a corporate body, it will be well to consider the method of establishing a Commission. There is a code set down in the Act as to how a Commission shall be established. That code must be carefully followed out. In the Township of Toronto, the Council established a Commission in a voted area, including all that part south of Dundas Street. The Commission was carrying on very

successfully, everybody happy, paying their rates, getting their light, until one farmer complained about his trees being cut. He made a claim. The claim was not met. He sued the Commission. The case is Robertson vs Orr. Mr. Justice Middleton, examining the procedure, decided that the Commission had never been properly appointed and the poor plaintiff was out of luck. There was no Commission. That is not to be recommended as a method of carrying on business.

As to the qualifications of your Commissioners, I don't need to weary you with the exact provisions of the Statute for the election of the Commission. They are set out in detail in the actual sections. But there is a section at the close, which is important. Sub-section (4) of 37 says: "Except where otherwise expressly provided, the provisions of part 2, 3, and 4 of the Municipal Act which are applicable to members of Council and local municipalities shall apply to the Commissioners so far as they are applicable to Commissioners elected under provisions of this part."

In the old case of Rex et al against Herman, it was decided that a High School Trustee was not disqualified from being elected a Commissioner of the Water and Light Commission. That was under the old Municipal Water Works Act, and it was held that the disqualification arising from being a School Trustee was applicable only to Councillors. Even under the old Act, I think, that case went too far. I think the fair construction, under the old Act, was that a High School Trustee could not be a Councillor and therefore should not be a Commissioner. Notwithstanding the result of that case, we now have it expressly provided in the Public Utilities Act that Parts 2, 3 and 4 shall apply. That includes Section 53 of the Municipal Act, which definitely disqualifies a school trustee. That is one of the sections of the Municipal Act which have to deal with the election of members of Council and their disqualification by unseating. Those provisions are imported directly into the Public Utilities Act, and govern the election of Commissioners.

Next, as to the method of carrying on business in the Commission, I have referred to the Commission being a Corporate body. Sound business sense would require that the Commission carry on their business regularly like any other company would. The Commissioners should carry on just as Directors would.

It is always necessary in Company affairs that the Directors should not carry on business except at a meeting of Directors. True they sometimes get by because they are all good fellows and they stand by each other, but if anything happened that would be investigated and the proceedings might be invalidated. The same thing should apply in the Commission. A regular meeting should be held in regular form, and the minutes kept if, for nothing else, for record purposes, because business afterwards is misunderstood or is apt to be sometimes misinterpreted. Business should be done by resolution or by-law as in a company.

Another point after the Commission is established, is the question of

officers and the relation to the old officers. The act provides that the officers and employees shall continue until removed by the Commission unless terminated sooner. The first officer to consider is the Treasurer. After the Commission has been established and invested with all these rights and powers, there is the provision that nothing shall take away from the Council its authority with reference to providing the money. Council has to follow the ordinary means of raising Debentures by by-law with the assent of the electors. When the money is thus provided, and in the control of the Municipal Treasurer, what is the function of the Treasurer? He is City Treasurer also under this Act, until the new Treasurer is appointed as Treasurer for the Commission, which is a distinct officer. In an outside municipality a dispute arose. The Treasurer, for reasons of his own, whether he thought a great deal of his office, or was an over canny Scot, I don't know, but he refused to pay out any moneys until the Commissioners came into his office with the actual orders or vouchers, and he personally audited them; then he would issue the cheques. It required stern measures to bring him to time. One of the measures was a letter written to the municipality by one of the most eminent authorities in Western Ontario on Municipal law, the late Mr. Matthew Wilson, of Chatham. This took place, I might say, quite a number of years ago; but one or two sentences in his letter may be of interest. "Unless required by the Commission, the Treasurer need not have any other than certificates for his vouchers, that is, requests from the Commission. In my opinion, the Treasurer for the municipality remains Treasurer of the fund until the Commission takes some action by by-law to appoint and regulate the conduct of the Treasurer by by-law. The Commission is a Corporation, and, in my opinion, has power to pass by-laws to regulate the management. It has power to appoint and remove officers and servants, just as the Municipal Council has power in regard to the general affairs of the municipality. In my opinion, the moneys should be kept by the Treasurer in a special account, under the direction of the Commission, and not under the direction of the Council of the municipality. If the Commission desires to change the custodian of that money, it can do so just as Council can change the custodian of its general funds, and the Commission has the right to direct in what bank the money should be deposited and kept. If the Treasurer of the municipality should remain the Treasurer of the Commission, then he should be guided by the Statutes and Council's by-laws and resolutions as to the general funds of the municipality and by the Statutes of the Commission, by-laws and resolutions, as to the Commission's moneys. They should not be mixed. I advise the Commission, control the money, and not the Council."

Of course, you must draw a distinction between controlling and possessing it, which is sometimes rather important. To get possession, the Commission must appoint a Treasurer of its own. This is advisable in every

case. I think you should pass a general by-law declaring how the Treasurer is to be appointed, and to regulate the hours of his office, his remuneration, and what books of account he should keep, to provide how the certificates of the Commission are to be signed and so forth. I recommend general by-laws as to the conduct of the business of the Commission, and put it in regular form, just the same as the business of the Council of the municipality is governed by the by-laws of that municipality. Before passing a by-law, you should adopt a seal with which to execute the by-law. The by-law when passed should provide all the details for the convenient working out of the financial affairs of your Commission. The Commission is a corporate body, and should carry on its business as regularly as any other company, not only pass its by-laws for general purposes for the conduct of business, but pass regular resolutions and by-laws in carrying on its business. There is a slight distinction to make here. Under the Municipal Act, there is special provision that the business of the Council shall be carried on by by-law, that is in order to keep better check on the proceedings by having three readings of each by-law. This requirement of a by-law every time does not apply to the Commission. Rather the Commission should proceed similarly to a company where a by-law is passed for something of general application or of great importance and a resolution for a single transaction of less importance.

It would be well to turn for a moment to one very essential thing in dealing with municipal corporations and councils, namely, the necessity for a by-law to commit a municipality for any debt or liability which is to extend beyond a year and also to validate a contract of the municipality, which is more than routine. Two cases—and they happen to be the same company, strange to say, though quite a number of years apart. The first one is the Waterous Engine Company against the Town of Palmerston. The town ordered a fire engine and put it in the hall, tested it; after about a week or so, ordered the company to remove it. The contract was under the seal of the corporation, but there was no by-law, and it was decided that the Waterous Engine Company could not recover the price of that fire engine from the Town of Palmerston, because there was no by-law. The specific provision of the Municipal Act requires a Council to act by by-law. There was a similar case in the Town of Capreol, the Waterous Engine Co. vs. Capreol. The Municipal Corporation is not liable on a note given for part of the price of a fire engine, said note being signed in the name of the Mayor and Treasurer, but not under seal, and no by-law having been passed.

Just to digress again for a moment, to show how close to the surface some times our history comes, even in the dry subject of the law. The following quotation is from the case of London City against Wood: "If Corporations have power to make by-laws, they must have power to inflict penalty, and in England it must be a pecuniary one. A corporal one, it cannot be,

by the law of England; it being against the Magna Charta. That special custom going back to the days of King John when they abolished corporal penalties, except within the limits set by Parliament, and this pecuniary penalty must be levied by distress or action for debt, and there can be no other remedy under the law as it then stood, and surely there can be no exception that this penalty goes to the use of the body politic whose laws are broken and despised, and therefore it is fitting that they should have a penalty."

Another point to consider is the limit of jurisdiction of the Commission. The jurisdiction of the corporation is limited to the limits of the municipality in the absence of special legislation authorizing an extension. Similarly the rights, powers, authorities and privileges conferred on the Commission would be similarly limited. A case in point is Ottawa Electric vs. Eastview. It was a case of running busses. The railway was operating busses to the Town of Eastview, and Eastview attempted to tax them, and, as the law then stood, they had no power. These busses coming in from outside Eastview, it was beyond the jurisdiction of the municipality when they attempted to interfere with traffic from other points. There are many other cases that could be cited on the same principle.

I would like to cite one other quotation of interest. It takes us rather far afield to the Judicial Committee. It is a case which came up from Alberta as to the liability of a Public Utility Commission. The Judicial Commission of the Privy Council pointed out that, in new countries, the authorities are frequently obliged to embark upon undertakings which, elsewhere, are left to private enterprises, such as the construction of railways, canals and other works, for the completion of which it is necessary to employ many inferior officers and workmen; that it was under these circumstances, expedient to provide a remedy for persons injured while such works were being carried on. This rule of construction only goes this far, that when a Government engages in a commercial enterprise, it shall be held, by that very fact, to have waived, as respects that business, its immunity from actions for tort. Ordinarily, a Government cannot be sued, but this was the Government of Alberta, and it was held on that very special plea as a new country employing inferior officers and workmen, that the Government should be liable.

An important point arises in this connection. One of the provisions of the Municipal Act is that, if the municipality is sued, and the municipality has relief over against another party, such as the Utility Commission, it is necessary to observe the provisions of the Municipal Act to secure the rights of the Commission, because if judgment is secured against the municipality and the Commission has not followed them, the Commission may be precluded from raising defences that it could have raised if it came into the original action and disputed the negligence. But if they take proceedings under Section 474 of the Municipal Act and give notice,

then, if they are not properly brought into the action and they are afterwards made a party to pay the judgment that the municipality has had given against it, the Commission can go right to the root of the matter, open it all up again and dispute it. It is a very small point, but one that may be useful to remember. If the action is for negligence and the suit is brought against the municipality, the Commission may be liable in respect to the municipality and the proper steps should be taken to see that the Commission's interests are protected while the original suit is still before trial, otherwise you may be precluded.

Another question is the interference with the Commission's business; a ratepayer is not entitled to bring into Court a person who is alleged to be indebted to the Corporation. In a case of remission of electric rates, it was held that the individual has no jurisdiction to commence any such suit. Of course you know that the Public Utilities Act and the Power Commission Act working together place in the hands of the Ontario Commission, as the supervisory body which is responsible to the Government, the control of rates, and machinery is provided in the Power Commission Act.

A case on this question is Hamilton Distillery Company vs. the City of Hamilton, and the Hamilton Brewing Association vs. the City of Hamilton. This was in 1906, just after the three-fifths vote came into effect; and I don't think the three-fifths vote ever bothered the City of Hamilton very much. What they attempted to enforce was the rule that the Hydro rate imposed by municipal authority must be an equal rate to all consumers unless express legislative authority has been given to discriminate. The rate must be fair and equal. It was claimed that Hamilton was attempting to make a special rate against these two institutions. Now the Provincial Commission would have control of the rate.

Another important issue is arrears of rates. It is a pretty touchy subject, and I would recommend, rather than attempt to deal with it here, that every one very carefully look into the provisions of the new Public Utilities Act, which first came into effect, under the Statutory Amendment Act, last year, displacing the old provisions as to lien. The difference is quite marked, as it is limited to three months prior claim and there shall be a lien and charge, not upon the land, but only upon the estate or interest in such land, of the person by whom such amount is due. On the other hand you have the additional right given you that you can yourselves collect by distress upon the goods and chattels of such person, or by the sale of his estate and interest in the land. If this is not done, then, upon notice to the clerk of the municipality of the amount due, and of the land upon which the lien is claimed, he shall enter same upon the Collector's Roll, and then the Collector shall proceed in the same manner as with municipal taxes by seizing the chattels or selling the land. It is quite a marked change. There are no decided cases on it yet. I am happy to say

most of these affairs are disposed of without reference to the Court.

One further matter. That is the standing in bankruptcy. Bankruptcy legislation is Dominion, and, within its limits overrides Provincial legislation. What priority of claim has the Utility Commission in a bankruptcy where there are not sufficient assets to meet all the claims? The Crown has a lien for its taxes, where lien is given by Statute whether the Crown is represented by the Dominion, the Province or the Municipality. The Dominion Government has priority of claim, only insofar as it has a lien on the estate of the bankrupt, and for certain taxes like income taxes and business profits tax, it has no such lien, and therefore cannot claim priority. On the other hand the lien given in the Public Utilities Act, if it is good in fact, gives priority to the extent of that lien only, not to the full extent of the claim. It might so happen that there was a case where the premises were not of the full value of the claim. Besides the interest in land, you have the right to seize the goods by distress. There is no lien on goods and prior rights in bankruptcy in respect to goods depend upon seizure, *i.e.*, possession is everything. The same thing applies to a claim that is settled on a judgment. If you allow a claim to go to judgment, the lien is lost. It is merged in the judgment. The only other way is by the seizure of goods. The Statute gives you a lien on the estate or interest of the bankrupt in that land. That is a little difficult to work out some times. Mr. Justice Fisher has had several cases, and he has decided along the lines just mentioned in a fairly recent case, *re* the Thompson Knitting Company down at Bowmanville, 5 Canadian Bankruptcy Reports. There are some other matters, but the hour is getting late, and I think I had better not weary you any further with the dry subject of the law. I thank you very kindly.

Discussion

Mr. J. J. Jeffrey, (H.E.P.C.): Mr. Chairman, there are a couple of matters I would like to bring up, which I think Mr. Hanna might explain for us. I think, in Niagara Falls, several years ago, a wire fell during a storm. A boy came along, picked it up and was badly burned. That case went to Court, and the Judge ruled that it was negligence on the part of the local Commission in not keeping the trees trimmed as it was shown that the wires, where they had broken, passed through the trees. The experts who gave evidence brought out the point that the wires might have been weakened by arcing grounds to the limbs of the trees, or the limbs might have been large enough, during the windstorm, to exert sufficient mechanical force to break the wire. Now, the local Commission, being a Corporate body and liable for the accident, have they got the power to trim trees where they see it is necessary? That is one point. Another one, has the local Commission, being a Corporate body, and liable for any accidents or incidents in connection with the business, have they got full power to locate poles on the streets where they see fit? Just those two points.

Mr. Hanna: In answer to Mr.

Jeffrey's first point, the question of negligence on the facts that are quoted, of course every question of negligence turns on the individual facts of the case. But there was a similar case in Toronto, Huestis vs. Toronto, in dealing with the wire and the falling of a tree, and from the facts of that case, it was held that the city workmen should have known that that tree was rotting. There was a dead limb. Everybody going by could see a large number of ants working. These workmen of the Parks Department tended the trees on the street, and should have known it was in a dangerous condition, and therefore, the city had notice. Apparently this Niagara Falls case was a somewhat similar thing, with the actual condition of the wire. Therefore, not trimming the tree created the danger, of which the Commission was advised and should have taken the proper steps in trying to prevent their carrying a dangerous article on the public highway, where the public have a right to be, and the Commission must exercise more than ordinary care. As to the other question, the right to trim trees, certain rights are given to Utilities such as to go on premises of the Corporation for the purpose of laying down, taking up and examining, keeping in repair, pipes, wires, etc. Now I think that is wide enough to give them the right to place their poles on the highway with the necessary clearance for safety. The other question, as to placing their poles where they please, I am not prepared to give any definite ruling on that point. As a matter of fact, I think the cases are rather against it, in a certain case where the Statute apparently stated clearly that there was the right to place wires along, or across the highways, it was decided that "along" did not mean on the highway, but in the farmer's field parallel to the highway. In other words, it is an extraordinary right that is given, and the Courts are bound to limit it to as modest proportions as they reasonably can, because it is interfering with other rights. Just one short phrase from the judgment may make the point plain. "The intention of the Legislature to enable any public body to invade the province of another public body, where it is not clearly expressed, will not be implied." The usual inference taken is rather that, when the ownership and control of a highway is in the municipality, unless the express words of the Public Utilities Act are strong enough so that the Public Utilities Commission, exercising those rights, can override the general right, then the municipality would have some say as to the location on the highway.

Convention Papers

Following the usual custom, this and the preceding number of the *Bulletin* have been devoted to the publication of papers, addresses and reports given at the recent convention of the Ontario Municipal Electrical Association and the Association of Municipal Electrical Utilities. The obtaining and the preparation of those papers, etc., has entailed considerable thought both on the part of the committee and of the authors, which should be appreciated.

The time is approaching when a decision must be made as to the program for the next convention, which is to be held at Niagara Falls on June 13th to 15th. To make that convention worth while, the papers and discussions should be such as will benefit the delegates in the performance of their duties in the operation and management of their respective utilities. The committee has always had this in mind in preparing for former conventions, and it will be agreed that its efforts in the past have been fairly successful.

There is however a feeling that there is room for improvement and that the contributions to the convention program could be made more beneficial than in the past. The members of the committee have their own ideas but feel that there are subjects in the minds of the other utility officials that are worthy of consideration.

The convention is held for the mutual benefit of the Municipal Electrical Utilities in Ontario and their operating officials. There can be no doubt that those officials have encountered problems in connection with their several systems, some of which they have solved but have not passed on, while others are still waiting solution, or suggestions that will lead to it. By advising the Papers Committee of such problems they would not only be assisting considerably in the preparation of the convention program but also in providing subjects for discussion that will be of general interest.

Some may feel that the questions they have in mind are not of sufficient importance to be made the subjects of convention discussions. Others may not look upon them in that way. But each wishes to benefit by the experiences of the others, and the convention gives the opportunity for the general interchange of ideas. With this in mind this appeal is made, and it is hoped that all will act on it and send their suggestions to Mr. O. H. Scott, Local Manager, H.E.P.C. of Ontario, Belleville, who is chairman of the Papers Committee, as soon as possible.

Suggestions Wanted

Members of the A.M.E.U.

Gentlemen:

As President of your association for the current year, I am particularly anxious that the association may continue to be a real live organization, not only at convention periods but during the entire year.

The Executive will welcome any suggestion as to how the association could be improved or made more helpful to the individual members; many matters of interest must suggest themselves to the various members from time to time, and if these were noted and passed on, your executive would be materially assisted in making our association a real benefit. To this end we solicit the kind co-operation of every member.

Respectfully yours,

(*Sgd.*) J. G. Archibald,
President.

Dealers Fined in Toronto Police Court

As a result of a recent survey made by the inspectors in Toronto, a number of charges were laid against an electrical and hardware jobbing house for selling unapproved electrical equipment without the required legible notice that the use of such equipment in the province of Ontario is unlawful. The complaints laid showed that this company had persisted in selling to retail hardware merchants in Toronto 250 watt sockets, unlisted snap switches and a number of very cheaply built air heaters. A conviction was obtained and the minimum fine imposed as this was the first charge laid agains this company. For each such offense a penalty of $50 may be imposed.

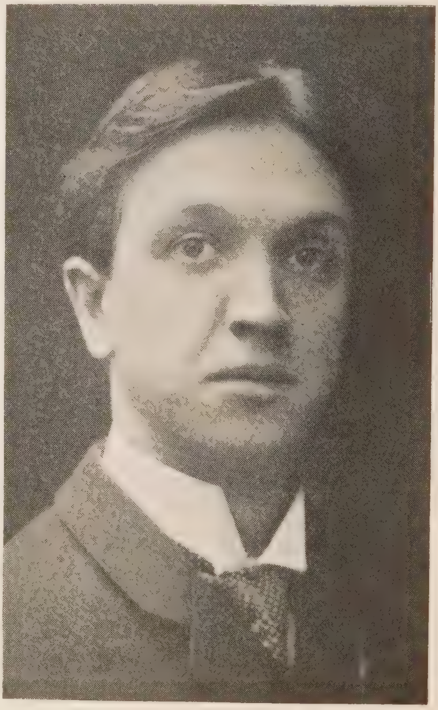
Another case, this time against a fixture supply house, resulted in a conviction for furnishing 250 watt pull chain socket bodies in ceiling fixtures supplied to a large institution.

There are still on the market in Ontario a number of porcelain receptacles with a pull chain mechanism rated at only 250 watts but these are only accepted for glass enclosed ceiling lights. At the urgent request of the Commission a number of manufacturers are developing these devices with 660 watt pull chain mechanisms and as soon as these appear in production temporary approval of the 250 watt mechanisms will be entirely withdrawn.

It may be well to point out at this time that the new Canadian Electrical Code specifies that "no medium base lamp socket rated at less than 660 watts, 250 volts shall be used." It is hoped that the general enforcement of this rule throughout Canada will simplify the production, distribution and inspection of sockets and receptacles.

George Wurster, Preston

We deeply regret to report the death of Mr. George Wurster, which has removed from the municipal field one of the most likeable men in the organization. In his position of town clerk and secretary of the Public Utilities Commission of Preston, he had the respect and co-operation of all



Late George Wurster

with whom he came in contact. In private life his sterling qualities endeared him to a host of friends, and our sympathy is extended not only to his family, but to the municipality which has lost a man well and favorably known.

Mr. Wurster was born in Preston forty-seven years ago, the son of Mr. and Mrs. Fred. G. Wurster, one of the oldest families in the neighborhood. He joined the 61st battalion of Winnipeg in 1915 and served on the front line in Flanders for over two years. Upon his return in 1919, he was appointed town clerk and secretary of the Public Utilities Commission. A week before his death, he was also appointed a justice of the peace for Preston and Waterloo County. He was an accomplished pianist, took an active interest in the Preston Silver Band, and was a popular member of the A.F. & A.M.

W. G. Ferguson, Peterboro

After a lingering illness, which confined him to his bed since last October, William Graham Ferguson, one of the oldest and most respected residents of the City of Peterboro, passed away at his home on Wednesday morning, February 29th, in his eighty-first year.

The late Mr. Ferguson came to Canada from Scotland about 1866. Having learned the grocery business in his native land, he became a member of the staff of Nicholls & Hall, grocers. In 1875 he embarked in the grocery business on his own account in partnership with the late Peter Connal.

When the Otonabee Power Company was formed in 1901, Mr. Ferguson became one of the original directors and managed its affairs from 1906 until the company's system was merged in that of the Peterboro Public Utilities Commission. In 1916 he became manager for the Hydro-Electric Power Commission of Ontario in Peterboro, operating the Peterboro Street Railway and the Peterboro Gas Utility which were under his supervision, until his retirement about two years ago.

In public affairs Mr. Ferguson was a member of the Peterboro Board of Education and of the William Hall Poor Trust.

He is survived by two sons and one daughter, his wife having predeceased him two years ago.

Little Injuries

Quite a considerable fraction of the industrial accidents that cause permanent partial disability result from infection. The wound, originally slight, becomes poisoned by the entrance of microbes, and serious consequences follow. Nearly all of these unfortunate cases would have been trivial and unimportant, if the injuries had received prompt antiseptic treatment, administered by a doctor or other properly qualified person. Blood poisoning comes from small injuries just as quickly as from large ones.—*The Travelers Standard.*

List of Electrical Devices, Material and Fittings

Approved by the Hydro-Electric Power Commission of Ontario in February, 1928.

Appliances

FRED T. BROOKS, 28 Mary St., Hamilton, Ont.

Electrically-illuminated display signs.

* * * *

CANADIAN WESTINGHOUSE CO. LTD. Hamilton, Ont.

"Westinghouse" induction motors of the split phase starting type, Type W, S. No. H 15165, H15166.

* * * *

COMMONWEALTH ELECTRIC LIMITED (Submittor), 40 Wellington St. East, Toronto 2.

COMMONWEALTH ELECTRIC LIMITED, (Mfr.) Morrell St., Brantford, Ont.

Portable air heaters "Globar" type. Cat. Nos. 107 and 117.

* * * *

PHILLIP GIES PUMP CO., LIMITED, Kitchener, Ont.

Electrical Equipment for Oil-burning Furnaces.

* * * *

*BASTIAN-MORLEY CO., LaPorte, Ind.

"Premier" automatic electric storage water heater "Marvelectric" Circulation type water heater.

* * * *

*ELECTROLUX SERVEL CORP., 51 E. 42nd St., New York, N.Y.

"Electrolux" household refrigerating machine.

Marking: "Electrolux", Type "WG75" or "WE75" and name and address of manufacturer on name-plate.

* * * *

*HEIDBRINK CO., THE, 2633 Fourth Avenue, S, Minneapolis, Minn.

Electric Heaters for attachment to apparatus employed for administering gases. Model C for use with Nitrous oxide gas. Model D for use with Ethylene gas.

* * * *

*NATIONAL ELECTRIC WATER HEATER CORP., 64 East 8th St., New York, N.Y.

Electric Water Heater. "Geyser".

* * * *

*PROPP CO. THE M., 524-528 Broadway, New York, N.Y.

Christmas Tree lighting outfits, Cat. Nos. 8, 80, 83, 84-5, 85F, 87, 87F, 108, 118, 118F, 808, 816, 842, 1080, 8008, 8016.

* * * *

Fittings

W. H. BANFIELD & SONS LIMITED, 370-385 Pape Avenue, Toronto, Ont.

Receptacles for attachment plugs and plugs. Composition, flush, single and duplex outlet types, Cat. Nos. 140, 142.

Marking: "Banfield", rating in volts and amperes, and catalogue number.

* * * *

THE DUNCAN ELECTRICAL COMPANY, LIMITED, 2 Inspector St., Montreal, Que.

Medium base sockets, keyless, brass shell 1/8 in. cap. Cat. No. 661. Medium base receptacles, all porcelain. "D". Cat. Nos. 1683, 1684, 2748, 2749.

Receptacles for attachment plugs and plugs, "Duncan" flush type with all porcelain base, without plate. Cat. No. 316A; with plate Cat. No. 316B.

* * * *

*Hoosick Falls Radio and Electric Parts Mfg. Co., Inc., Hoosick Falls, N.Y.

Receptacles for attachment plugs. Single and duplex type. Cat. Nos. 700-01.

Marking: "Hoosick".

* * * *

*Propp Co. The M., 524-528 Broadway, New York, N.Y.

Current Taps, composition body, two, three and four outlet. Cat. Nos. 1, 2, 3, 4, 11, 15, 16, 17, 19, 22, 44; three outlet Cat. No. 30.

"Bakelite" body, two outlet.

Composition attachment plugs. Cat. Nos. 55, 56.

Separable attachment plugs. Cat. No. 526, consisting of cap, Cat. No. 526C, and body Cat. No. 526B; Cat. No. 528, consisting of cap, Cat. No. 528C and body, Cat. No. 528B.

Marking: "Propp".

* * * *

Switches

*General Electric Co., Schenectady, N.Y.

Automatic Switches, pressure-operated type (As listed on Underwriters' Laboratories card dated, November 11, 1927).

*Industrial Controller Co., Milwaukee, Wis.

Automatic Switches, magnetically-operated type. (As listed on Underwriters' Laboratories card dated December 20, 1927).

* * * *

*Dunn, J. Struthers, 1130 Race St., Philadelphia, Pa.

Automatic Switches, magnetically-operated type. Style No. 420.

Marking: J.S.D. inside of a triangle stamped upon moving contact.

* * * *

Miscellaneous

*Belden Mfg. Co., 23rd St. and Western Avenue, Chicago, Ill.

Rubber-covered fixture wire. (As listed on Underwriters' Laboratories card dated June 8, 1926).

* * * *

*Canadian General Electric Co. Ltd., Toronto.

Slow-burning fixture wires.

Marking: One black thread cabled with copper strands.

* * * *

*Live Wire Co., The, Guelph, Ont.

Flexible Cord.

Fixture wire, rubber-covered.

Marking: One purple thread cabled with copper strands.

* * * *

*Propp Co., The, M., 524-528 Broadway, New York, N.Y.

Cord Set including fuseless attachment plugs for use with portable heating appliances. Cat. Nos. 550, 560.

---

*These devices are under the Underwriters' Laboratories re-examination or label service.

NOTICE

The new Edition of the Rules and Regulations for Inside Electrical Installations of the Hydro-Electric Power Commission of Ontario are now available for distribution and may be obtained at any of the District Inspection Offices of the Commission, or from the Electrical Inspection Department, Room 408, Northern Ontario Building, Toronto, at 25c. per copy.

These rules will become effective throughout the Province on May 1st, 1928.

ELECTRICAL INSPECTION DEPARTMENT

Hydro-Electric Power Commission of Ontario

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

The Toronto-Leaside Transformer Station

CONSTRUCTION was started a few weeks ago, of the new 220,000 volt step-down transformer station of the Commission, to receive the power obtained by the Commission from the Gatineau Power Company. This station will be the first 220,000 volt step-down transformer station in Canada, and will also be, when completed, one of the largest transformer stations on the continent. As such, it will possess a number of novel features, which will be studied with interest by engineers and others having similar undertakings.

Location

The site of this station is in the town of Leaside, just South of the C.P.R. main line between Toronto and Montreal, and adjoining and to the north-west of the Thorncliffe race track. A location east of Yonge Street was the logical point for this station for several reasons, among which, first, the length of 220,000 volt line to the station was less than if the station had been located on the north or west side of the city; second, the Toronto district load, which is nearly one half of the total Niagara System load, could be most effectively supplied by locating the station at Toronto, rather than at some point west; third, the present high voltage stations of the Commission at Toronto are all located west of Yonge Street, so that a station on the eastern side of the city was necessary to balance up the locations, and keep the losses due to distribution at a minimum. The location selected was decided upon, only after a thorough study of the present and estimated future load distribution in Toronto and vicinity, the site being very close to the Theoretical load centre for the district it will supply.

Description of Station

The station site covers 12 acres, this relatively large area being necessary for several reasons. First, the

CONTENTS

Vol. XV **No. 4**

April, 1928

	Page
The Toronto-Leaside Transmission Station	113
Progress on the Gatineau-Toronto Transmission Line	117
Application of Hydro-Electric Power to Farm Work	119
New Grain Elevator at Midland	124
Protection Afforded by Fuse and Fuse Wires	125
Where Do Our Waves Go ?	129
O.M.E.A. Reports	133
A.M.E.U. Reports	140
Hydro News Items	142

quantity of power concentrated there requires equipment of large physical size; second, outdoor construction, which, although cheaper than indoor, requires additional ground area; third provisions for supplying the power to both the Toronto Hydro Electric System distribution circuits, by direct transformation to distribution voltage and also to the Niagara System direct at 110,000 volts; fourth the necessity for synchronous condensers to regulate the voltage at the station; fifth, the increased clearances required between wires and to ground due to operation at 220,000 volts.

The station may be divided into six principal sections :—

(1) 220,000 volt circuits and bus.
(2) Transformers.
(3) 110,000 volt circuits and bus.
(4) 13,200 volt circuits and bus.
(5) Synchronous condensers.
(6) Control room.

220,000 Volt Circuits and Apparatus.

The 220,000 volt lines from the Ottawa River terminate on what is known as a bus, and may be disconnected from it by means of oil circuit breakers. Provision is made for isolating each circuit breaker by means of disconnecting switches, so that repair work may be undertaken on the former without interrupting service. Each oil circuit breaker is approximately 22 feet high to the top of the bushing and occupies an area 45 feet by 10 feet. Each tank of which there are three per breaker requires 5,000 gallons of insulating oil. The circuit breakers are the largest in physical size and rupturing capacity manufactured. In spite of their large size, and heavy moving parts it is expected that they will completely interrupt the circuit in one half second. Seven of the circuit breakers will be required to handle the load contracted for with the Gatineau Power Company (230,000-260,000 h.p.)

Transformers

The 220,000 volt terminal of the main transformers is connected to the bus and transformation made in the windings of the transformers to 110,000 volts and 13,200 volts. These power transformers are of the largest practicable size, the limit in physical size being set by transportation facilities. Each transformer is rated at 15,000 kv-a., and has three windings, insulated from each other. Three transformers are connected in a bank, and a bank can take in 45,000 kv-a., at 220,000 volts, and deliver part or all of it to the 110,000 volt or the 13,200 volt circuits, as desired.

Toronto-Leaside Transformer Station as of April 2, 1928. On the right is shown the steel framework of the Erection and Office Building

Four of these banks of transformers will be required to handle the Gatineau contract, the capacity of the station being, therefore, 180,000 kv-a. or approximately 240,000 h.p.

The transformers are the largest single phase water cooled units in physical size, ever built, as far as is known. They are 32 feet in height to the top of the high voltage bushing and the tank proper is over 13 feet in diameter. Each transformer will weigh 368,000 lbs., or 184 tons, and will contain over 14,000 gallons of oil. The transformer is water cooled and requires 75 gallons of water per minute when carrying rated load.

110,000 Volt Circuits and Bus

Direct interconnection with the Niagara System is effected through 110,000 volt windings of the transformers and the 110,000 volt bus. This interconnection has great advantage in that at times when the Toronto load is light, power may be absorbed through the 110,000 volt windings of the transformers into the Niagara System. In an emergency, power may be obtained to supply a portion of the Toronto load normally supplied from the East, by feeding power in through the 110,000 volt winding.

In order to obtain flexible voltage control at the point of interconnection the transformers at Leaside are equipped with an under load tap changing device, which allows the voltage to be varied through a range of + or − 7½ per cent.

13,200 Volt Circuits and Bus

The distribution stations of the Toronto Hydro Electric System are supplied from this bus, and since the load power factor must be corrected before the load enters the 220,000 volt lines, the synchronous condensers which make this correction are also connected to this bus.

The large number of 13,200 volt feeders leading from this station has made the design of this bus and its circuit breaker arrangement a very complicated one, and due to the large amount of power that may be concentrated at a fault on this bus or

feeders, very large circuit breakers and a positive system of protection are absolutely necessary.

Synchronous Condensers

The use of synchronous condensers to regulate voltage is essential. This is due to the length of the line between Ottawa River and Toronto (230 miles), its relatively high voltage, and to the fact that the distribution voltage at Toronto must be held within very narrow limits, to give satisfactory service.

Control Room

The control of all circuit breakers, disconnecting switches, tap changers, and synchronous condensers is centered in a control room 35 feet by 45 feet. Metering instruments are located here so that the operating staff will know at all times the conditions of voltage, power factor and load, and thus be in a position to control these quantities intelligently, and make necessary operations under an emergency in the quickest possible time.

Practically all the equipment for this station is being manufactured in Canada, and the complete design of the station is the work of the Commission's engineering staff, who have spent a great deal of time to ensure that this station will be second to none, and according to the most modern and best practice in every respect.

Active work at Leaside was started a few weeks ago, the first building to be constructed being the erection building required for the assembly of the electrical equipment. This building is fitted with a 75 ton electrically operated overhead travelling crane to facilitate handling of heavy parts. The buildings will be of brick and concrete with structural steel framework. The manufacture of the electrical equipment is well under way at factories in Peterboro, Toronto, Hamilton and St. Catharines. The structural steel is being fabricated at Toronto and Walkerville. The progress schedule requires the first portion of the station to be ready to receive power by October 1st, 1928.

Progress of the Gatineau-Toronto 220 kv. Transmission Line. (First Circuit)

PROGRESS on the Gatineau-Toronto Transmission Line was reported in the December 1927 issue of "The Bulletin," since when the work of delivering towers, erecting steel, and stringing conductor has been proceeding according to schedule.

Up to the first week in April, 1928, 125 miles of tower footings were installed ready for the support of the towers; on 107 miles of these the steel towers were erected, ready to support the ground cables and conductors; and ground cables and conductors were strung and clamped for about 48 miles.

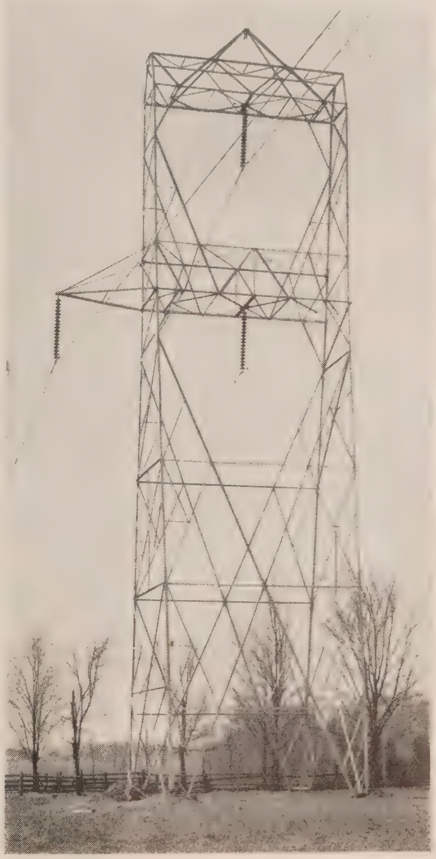
Scheduled deliveries of steel towers have been made over snow roads to the eastern sections of the line during the winter months, and all steel towers are now delivered on the line with the exception of some 7 or 8 miles of towers for the extreme eastern end of line, which are fabricated and ready for shipment when required.

Fabrication and delivery at point of use of the aluminum conductor for this line is 55 per cent. complete. The ground wire is about 90 per cent. delivered.

Owing to difficult transportation conditions after the spring break-up, operations have been largely discontinued since about the first of April. Work will commence again just as soon as the roads and farm lands will support the necessary transportation.

One comparatively inaccessible section, in the County of Frontenac, some 12 miles in length, has been completed, including a telephone line, entirely under winter conditions since it was recognized that this work could be done during the winter season with least expense.

The photograph shows the transposition tower which is being used on this line. A view is also reproduced



Transposition Tower

Stringing Cable and Pulling up Slack During Winter

of stringing conditions in winter when conductors in being hauled over the snow are not likely to be scored by coming in contact with stone and other hard substances.

How the Public is Impressed

The following flower was plucked from a description of the inauguration of a new generating set at Portsmouth, which appeared in a local newspaper:—"The Company then entered the power station and inspected the new turbine, a great colossus of machinery concealing within its prosaic shell sufficient power to kill every inhabitant of Portsmouth."

This vision of wholesale electrocution, whether deserved or not, is dispelled, however, by a subsequent statement that "those present who appreciated this fact were consoled by the knowledge that its great forces will be directed to the welfare of the people instead."—*The Electrical Review.*

Application of Hydro-Electric Power to Farm Work

Article No. 12

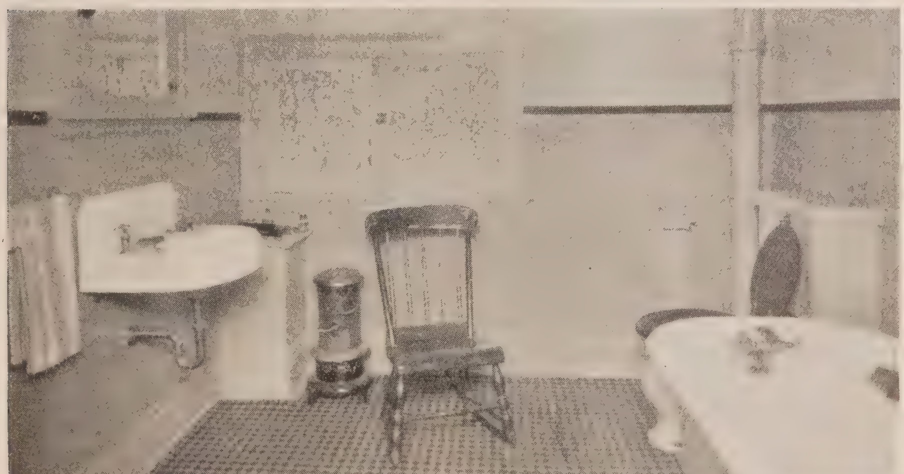
Farm Water Service

PURE water as an element of food is an essential to produce healthy and robust development either in human beings or animals and, therefore, an ample supply of it is a necessity on farms. Lack of it is likely to bring about dire results in both man and beast, All residents in rural districts should take advantage of the privileges available through the Ontario Department of Agriculture to keep the source of supply safe and have periodic tests of the water to determine the purity of output. Bulletin No. 330 of the Ontario Agricultural College gives complete information on Water Supply and Sewage Disposal.

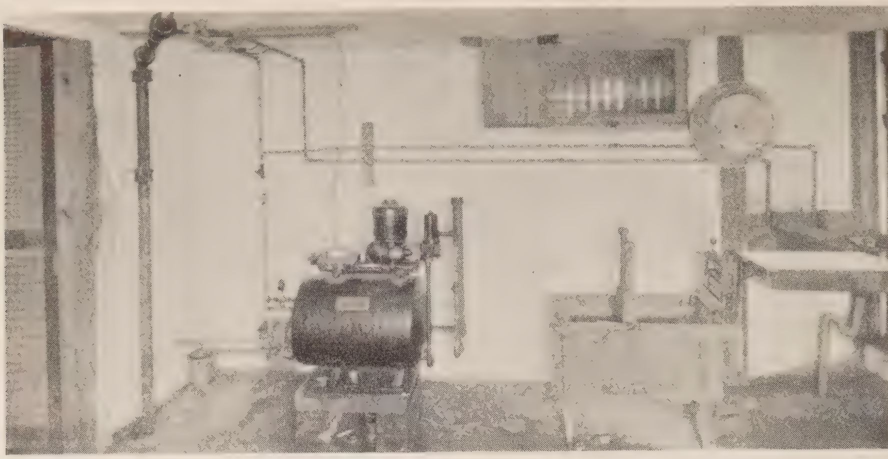
Soft water is to-day considered necessary for cleansing purposes, on most farms, the hard water from wells being harder than that available in towns and cities where the source of supply is from large open bodies of water. The farmer's problem, therefore, has to include practically two services instead of one.

The Commission's interest is in water service, not the supply. Convenient water service results in liberal use. Liberal uses in animals for food increases the gain in meat or milk with but slight increase in solid foods ; increased uses of water for cleansing purposes tend to safeguard the health of humans and will not harm the animals.

Water service on farms can be arranged in many cases by adapting present pumping installations to



A fully equipped bathroom on the second floor. This installation is on a farm in the Woodstock, R.P.D.

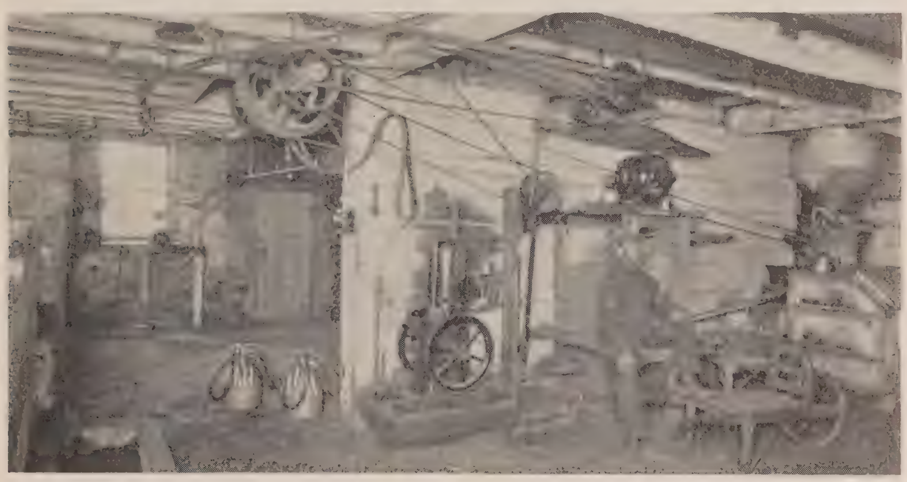


Automatic pumping systems are in use on many farms, Hydro-Electric power and the electric motor making it possible to have a water service on farms equal to city service, where a public supply of electric service is available. There are quite a variety of these plants on the market in Ontario priced at about $100.00 up. They are delivered complete ready to connect to the electric supply, to the well, or cistern and the delivery system. This picture shows the pumping system in the basement, a sink with hot and cold water, and a washing station for the men to clean up before going upstairs. Behind the lattice door is a "Comfort Station."

A windmill pump in the Woodstock, R.P.D., where the mill, after being damaged during a storm, was superseded by a 1-horsepower motor. The housing, erected in an emergency, covered by metal to insure waterproofing seams, serves so well that at the end of three years it is still in use. This supply serves the barn only. A hand-pump at the sink in the kitchen supplies hard water in the house from a well just outside, while soft water is supplied from a storage tank in the attic, catching rain water from the house roof, which serves the bathroom, the kitchen for washing purposes and the laundry in the basement.

electric drive and manual control, if storage be available, either by use of pressure or elevated tanks existing or to be installed. There is always a height available some place, the attic, on top of the silo or an adjacent hill; an indicating overflow pipe will safeguard against spilling and resultant damage. The same tank divided, or two tanks in the same location, would provide storage for both hard and soft water.

Of the automatic systems the greater number of these at present available are for shallow or dug wells, where the maximum suction lift is



Two supply sources of water, one a well below the stable floor, the other the well in the yard below the abandoned windmill. The three-horse-power motor in the stable, besides other uses, drives two gear jacks, the one operating direct through the floor to the well below the stable floor, the other driving a 160-foot jerk rod with one bell-crank at the end of the barn, and another at the pump under the discarded windmill, as a means of raising water from the deep well. This well supplies twohouses and part time to the barn. The uses of water from these sources include hard water for the houses, the latter being carried by hand to the houses, soft water from cisterns in the houses, with pump conveniently located, takes care of the needs in each from its own source for cleansing purposes.

A wooden pump on a farm in Waterloo County adapted to electric drive by using a gear jack in the space above this combination dairy and machine shop. The drive to the machines in this section of the building is through a line shaft from the 5-horsepower motor about 40 feet away; in addition to the pump a cream separator and an emery stone are driven, when needed, by the same line shaft. This water service is for the barn only. The supply for the house is from a well at the house. The ½-horsepower motor in the wood shed with line shafting provides power for a pump in the kitchen, which delivers water to a supply tank in the attic. This motor also provides power for a churn and washing machine.

28 feet. There are, however, automatic systems available for deep wells, these being lower in capacity with the same amount of power applied. In deciding on the size of pumping equipment, it is advisable to keep in mind former service from the same source, as increasing the output by using electric drive sometimes affects the supply; especially is this true where the service formerly in use was by hand pumping.

A suggestion frequently followed in installations on farms is to have the one motor drive two pumps, one for hard water, the other for soft, automatic control being applied to the hard water service, the soft tank having an ample overflow properly screened to assure continued operation, the surplus of water returning to the cistern.

When possible, and the well will stand it, the supply of all the hard water should be taken from the one well, storage made in the one tank and a piping system provided to take care of all of the needs at house, barn

and yards, as purity of supply is very much helped or affected by the amount used.

The water consumption on the farm depends largely on the number of animals and the desires, and number of the residents, on the place. The tabulation below from O.A.C. Bulletin No. 330 gives an estimate of the needs in gallons per person or per animal per day.

The accompanying illustrations show the water service now in use on four Ontario farms, having electric power service supplied by this Commission.

Many other complete installations of water service and systems exist on Hydro served farms, some quite simple in assembly, others more elaborate.

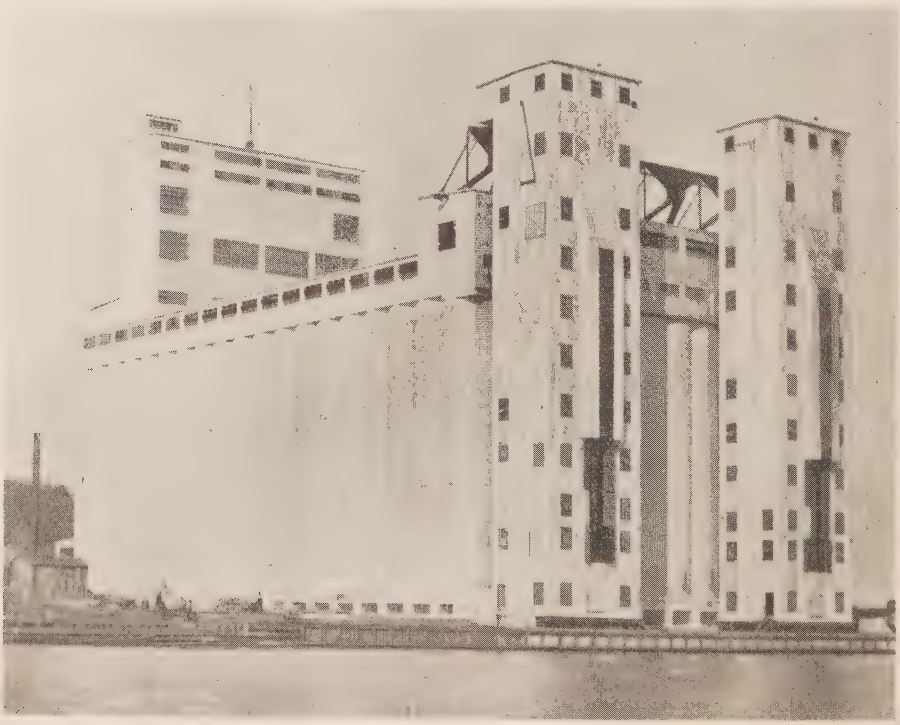
Water carried	8 gals. per person per day
Pump at kitchen sink	10 " " " " "
Faucet at kitchen sink	12 " " " " "
Running hot and cold water in kitchen	18 " " " " "
Complete plumbing with water under pressure	30 " " " " "
Bathtub*	8–20 gals. each time used
Closet*	3-5 " " " "
Lavatory (wash basin in bathroom)	1-2 " " " "
Sprinkling lawn	8 gals per 100 square feet
Soaking lawn	20 " " " " "
Cow	10 gals. per day
Horse	10 " " "
Hog	2 " " "
Sheep	½ " " "

* Water for these purposes included in the table is from "Complete Plumbing and Water under Pressure."

New Grain Elevator—Midland

A NEW grain elevator for handling lake shipments has recently been constructed and placed in operation at Midland, and the first shipment of grain was handled on October 10, 1927.

The name of the firm under which this elevator will operate is known as the Midland-Simcoe Elevator Company. The present grain storage capacity of the elevator is 2,500,000 bushels and it is contemplated to extend same in the near future to 5,000,000 bushels and possibly 10,000,000 bushels. The elevator is equipped with two marine legs at the present time, with facilities for adding a third leg when future extensions are undertaken. The storage tanks in the house are constructed of reinforced concrete. Electric energy for operation is obtained from the Public Utilities Commission of the Town of Midland, with service taken at 22,000 volts and stepped down to 550 volts for local distribution. The company has provided its own substation equipment, which consists of one bank of three 500 kv-a transformers self-cooled, oil insulated, 22,000 to 550 volts, 60 cycle, together with the necessary switching equipment for local feeder circuits. A static condenser for power factor correction has been provided and the lightning



arrester is of the multi-valve type. The metering equipment is connected on the high tension side of the station.

The contract for power calls for a reservation of 1500 h.p. and the addition of this load to the Midland System will give the local Commission six separate substations in operation, with a total load approximating 5,000 h.p., or, approximately 518 h.p. per head of population.

Protection Afforded by Fuses and Fuse Wires

By W. B. Buchanan, Testing Engineer, H.E.P.C. of Ont.

NUMEROUS cases have arisen in the application of fuses in which the operator apparently has lost sight of the fundamental principles of operation of fuses and their purpose and unnecessary damage has been done to equipment. He may not have been at all to blame for such results as he may on the one hand be obliged to follow some rule-of-thumb method which, developed to its best, is known as standard practice, and on the other hand his efforts are restricted or modified by the vagaries of the materials he is obliged to use. A brief discussion of some of the factors involved in the application of fuses is proposed with the purpose of refreshing the memory of those having to deal with fuse protection.

Constant potential distribution systems of electric power supply require conductors to be run in many concealed locations difficult of access. It is important for reasons both of economy of time and material that loads should be so controlled that when breaks occur in the circuit due to overloading, these should take place in such a location that no fire or other hazard be involved and that service may be restored as promptly and economically as possible. This principle led to the development of fuse-wire and enclosed fuses mounted in suitable well protected compartments. The essential operating feature is that the fuse element must clear the circuit before any damage is done to the feeders. The duty demanded of the fuse then depends not only on the current that will cause it to melt but on the voltage that will be established across its terminals after it has blown. A higher voltage service requires a longer fuse link and this affects the current rating slightly but the more important demand made by the higher voltage service is an increased strength in the case or container.

Standard cartridge fuses for voltages up to 600 volts are specified in detail in the Hydro Electric Power Commission's "Cartridge Enclosed Fuse Specifications, March 1919." These rules state the limiting variation permissible in the performance of the fuse from its nominal rating as follows :— "Rating."

"Fuses must be so constructed that with the surrounding atmosphere at a temperature of 24° C. they will

carry indefinitely 110 per cent. current without causing the tubes to char or the externally visible soldered connections to melt.

"With a room temperature between 18° and 32° C., fuses starting cold must blow on 150 per cent. current without causing the tubes to char or the externally visible soldered connections to melt, in the times specified below."

0 — 30	amperes	1 minute
31 — 60	"	2 "
61 — 100	"	4 "
101 — 200	"	6 "
201 — 400	"	12 "
401 — 600	"	15 "

This table recognizes the fact that as normally designed the heavier capacity fuses must be allowed a greater time to open the circuit on overload currents than those of smaller capacity. It is possible to design heavy capacity fuses that will meet the ten per cent. overload requirement and open the circuit on the fifty per cent. overload in very much less time than that specified. However, this discussion is not intended to cover the theory of fuse design but is limited to the application of such standard types as are available to the average consumer. The Rules and Regulations are quite explicit as to what capacities may be used in cases given up to 600 volts and generally the protection afforded when the Rules are followed will be satisfactory.

Fuses for use on 2200 volt circuits and higher cannot be applied with the same degree of confidence since variations occur due to the construction of the cut-out and in addition a greater latitude is obtained in the selection of the material of the fuse element itself and its mechanical arrangement. The more expensive forms of 2200 volt cut-outs are supplied with fuse elements which approach fairly closely to the current rating specified for 600 volt cartridge type fuses, with the time-lag allowed for opening on overload roughly proportional to their capacity. The fuse wire which is supplied for such applications as installation with the 2200 volt porcelain cut-out does not agree with its nominal rating in the same manner as the type just mentioned and further a rating supplied by one manufacturer may not agree with that given by another for the same maximum current. Some figures taken from published tables indicate that with one make a fuse wire rated at 1 ampere fuses at 3-¼ amperes, a 5 ampere at 10 amperes, a 10 ampere at 20 amperes, etc., these samples being of a certain length and exposed to free air. Obviously the figures would be modified when the section is longer than that stated also when it comes in contact with a cold body throughout its entire length.

Such pertinent data must be taken into account by an engineer when selecting the fuse ratings to be applied in transformer cut-outs. It frequently happens that the low tension fuses must be relied on entirely to protect the transformer from dangerous overloads. The high tension fuses are usually so much shorter in their time of fusing in case of heavy overloading that they clear the circuit before the low tension fuses have time to operate and long before a condition hazardous to the transformer has been reached.

Hence in order to maintain a reasonably satisfactory service to the customer it is frequently necessary to fuse the high-tension cut-outs to a current value which is far above that which the transformer can carry continuously. This is where discretion must be exercised by the engineer in charge as it is difficult to specify groupings which would be satisfactory in all cases. On the one hand a lighting load only on the secondary introduces no excessive rushes of current and if the secondary leads between the transformer and the secondary fuses be subject to accident, the high tension fuses must be depended on to protect the transformer. On the other hand a certain installation · consisted of a stone-crusher plant driven by a 40 h.p. squirrel-cage induction motor, supplied from 3–15 kw. transformers. The time required to get the crusher up to speed was so long that it was necessary to fuse the high tension cut-outs up to over four times full load current in order to maintain service at all. The secondary leads were short and the running fuses on the compensator could be depended on to protect the transformer from continuous overloads, hence it was felt that in this case adequate protection was maintained. The plant shut down after some months' operation without giving any cause to change the recommendations made on this point.

Much might be said about the design of fuses and the principles which must be followed to give a satisfactory device from the standpoint of general service. In practice the operator of a small system where costs must be cut to a minimum frequently finds it necessary to use rough and ready methods to restore service. When the expense of a heavy-power high voltage fuse carefully designed as to time-lag of operation on overload is warranted, the duty becomes equivalent to that of a circuit-breaker controlled by an inverse-time limit overload relay and the flexibility of adjustment of the latter may make it preferable to the fuse even at some increase in price. This would be more particularly true if the renewals of the fuse should develop into an important item.

National Electrical Safety Code

The fourth edition of the National Electrical Safety Code has recently been issued by the Bureau of Standards, Department of Commerce, Washington. This is a revision of former editions and includes sections that had been published separately in pamphlet form.

The present edition represents only minor changes in the general substance of the rules. The regulations dealing with line construction probably incorporate more important changes than any of the other parts, since it is this field of construction regarding which the views of operating engineers represent the greatest diversity of opinion. The rules of this part and also of part 4 have been entirely rearranged, and it is thought that the new arrangement will increase the facility of reference and make more clear the intended effect of the requirements.

Part 5, dealing with radio installations, is entirely new in substance and has been prepared to meet a very wide demand for guidance in the installations of both antennas and interior equipment.

This code represents a growth and development which will necessarily continue in the future as in the past. More specific requirements can be worked out with respect to many items covered by the rules, and more definite conclusions can, no doubt, be arrived at in the case of requirements regarding which there is not yet entire agreement. Such points will be the subject of further study not only by the bureau staff but also by representatives of utilities and other interests most seriously concerned with these subjects. If experience or experiment provides sufficient evidence for changing the requirements in future editions, it will, of course, be done, and every effort will be made to obtain data and accumulate experience leading to the formulation of modified rules which will meet with even more ready and general acceptance. The code rules specifically provide for variation from particular requirements when circumstances warrant different practice.

The rules have been made to recognize conditions as to climate and density of population where these involve a difference in the hazard or the number of persons exposed to the hazard. This is particularly true of overhead lines. While such treatment has added a considerable amount of detail to the rules and greatly increases the extent of tables found in the appendixes to part 2, it is considered necessary to properly cover the varied conditions met with in the field.

Copies of this code may be obtained by applying to: Superintendent of Documents, U.S. Government Printing Office, Washington, D.C., the price being given as $1.00.

Where Do Our Waves Go ?

OUR short wave radio stations at Toronto and Cameron Falls have now been in service for about twenty months interchanging messages over a distance of approximately six hundred miles in connection with the operation of the Thunder Bay system. The chief purpose of these stations is communication with each other, but the waves radiate in all directions and have been received at many points very remote from the stations themselves.

As explained in the November 1926 issue of "The Bulletin", radio waves having length less than sixty-six meters show skip distance effects. They rise to the sky and do not return to the earth until they have travelled many hundreds of miles, this distance depending upon the wave length, the season and the time of day.

The maximum skip distance for our stations appears to be about three hundred miles, with the wave lengths we use, for we do not receive reports of reception from points within this range.

Beyond this distance, however, our signals evidently are very strong and have been received with remarkable consistency at far distant points, even in Australia and New Zealand.

In many instances the reports cover complete two-way tests between our stations themselves by both code and voice, the latter having been used successfully in some experimental work. Some of the most interesting of the long distance reports have come by mail from the following points:—

North America	Mexico City	—	Mexico	—	2,200 miles.
	Kingston	—	Jamaica	—	2,300 "
	Tuinucu	—	Cuba	—	2,100 "
South America	Rio de Janerio	—	Brazil	—	5,800 "
	Montevideo	—	Uruguay	—	6,200 "
	Santiago	—	Chile	—	6,000 "
	U.S.S. Denver	—	Off South America	—	7,000 ? "
Europe	London	—	England	—	3,700 "
	Paris	—	France	—	3,800 "
Africa	Cairo	—	Egypt	—	6,300 "
Australasia	Auckland	—	New Zealand	—	9,200 "
	Rangiora	—	" "	—	9,700 "
	Sydney	—	Australia	—	10,300 "

Also, many other reports have been received from England, Italy, Spain, France, Cuba, Mexico, Honolulu and Australia.

All Canadian provinces, the Hudson Straits Expedition, and about forty-five states of the U.S.A., have sent in very good reports of reception of our stations.

The best report on voice tests came from Tuinucu, Cuba, where the complete conversation between our two stations was received clearly and continuously throughout our tests of one evening.

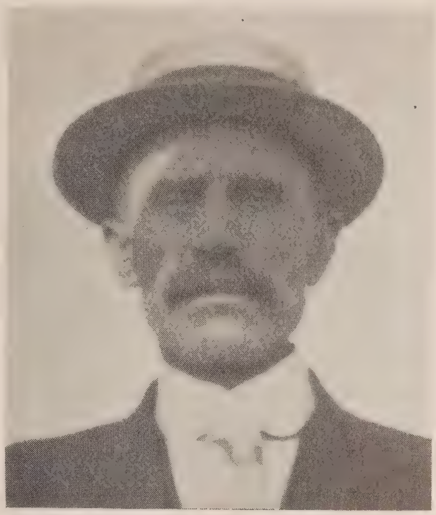
It may be surprising to some readers to learn that the radiations from those few short aerial wires secured to the mast on the roof of the Administration Building, or from even the fewer and shorter wires at Cameron Falls, travel effectively to such great distances. In every instance, however, the reports have been received through the mails and invariably they have checked with our records of operation.

Sir Lawrence Weaver Visits Queenston

A recent visitor to our Queenston Plant was Sir Lawrence Weaver, of England, one time architectural critic and now engaged in other work. Sir Lawrence disclaimed any technical knowledge of the operation of a Hydro Electric Plant, but he expressed himself as tremendously impressed with the Queenston Development on the grounds of its hugeness, its appearance of high efficiency and its architectural features. Sir Lawrence is a very strong advocate of the elimination of useless and meaningless ornament in the design of buildings, furniture and fixtures, and

in general was very generous in his praise of the Queenston Plant from an architectural view point because of the pleasing effect attained with the aid of nothing but the proper arrangement of essential parts; in a word, on the grounds of the fitness of everything for its purpose.

Mr. J. E. Addis, Alliston



Late John E. Addis

Mr. John E. Addis, Clerk of the Town of Alliston, and Secretary of the Alliston Hydro-Electric Commission, passed away at his home on Monday evening, March 19th. Mr. Addis had been in failing health since last summer, but continued in the work of his office until near the first of the year.

Mr. Addis was born in Ireland 1862, and came to Canada with his parents when a very small boy. His early years were spent on his Uncle's farm in the Township of Essa, and in the early eighties Mr. Addis took up farming independently on Lot 9 of the 3rd Concession of Essa, where he continued for some twenty years. Twenty-three years ago Mr. Addis moved to Alliston and in 1916 was appointed Clerk of the Municipality. He was also Clerk of the Eighth Division Court at Alliston, and Treasurer for the Union Cemetery Board of Trustees.

Alliston was connected to the Hydro System in June 1918, and Mr. Addis has been the Secretary of the local Hydro-Electric Commission from that time.

Mr. Addis was a most ardent supporter of the Hydro-Electric enterprize and was most zealous and efficient in connection with all of his duties in that connection. He was a frequent attendant at the summer convention of the A.M.E.U.

He will be remembered as an always courteous, solicitous, sympathetic, impartial and a most fair minded upright gentleman, and his loss will be deeply felt, not alone in the Town of Alliston, but by all people with whom he came in contact in the various branches of his activities.

Mr. Addis was a staunch Conservative in politics, and an Elder of the Wesley United Church, and was always actively identified with the Prohibition movement.

The funeral, which took place on March 21st, was under the auspices of the I.O.O.F., of which Mr. Addis was an active member.

He is survived by his wife, one sister, and two brothers, to whom we extend our deepest sympathy.

How to Choose a Motor

The three questions which a purchaser asks in buying an induction motor are : How much will it cost? What will it do? How soon can I get it? In the salesman's language these are called price, performance and delivery. It is concerning the second of these only that there can be any question as to interpretation of statement or figures.

What are the governing characteristics of an induction motor and how is its excellence measured and compared? The size or horse-power of the motor is not one of these, for the reason that different jobs have different requirements. Neither are the phase, frequency, voltage or speed. because these are fixed either by the supply circuit or by the requirements of the job. This leaves the following characteristics which are within the control of the designer and which can be studied and compared as a measure of the excellence of the performance of the motor: efficiency; starting torque; maximum torque; heating; power-factor; starting current; air-gap; insulation. To these, usually, are added mechanical features such as:—bearing dimensions, and whether bearing leaks oil which might be detrimental to the insulation; mechanical vibration; noise; form of slots and windings; appearance. Little attention is usually paid to certain other important characteristics, such as reliability low upkeep, ease of repair and minimum attention, as they can be taken for granted in the product of a reputable manufacturer.

In comparing the performance of two different types of motors, it is urgent that the comparison be complete, as a partial comparison of one or two characteristics may be very misleading. For example, it is by no means safe to assume that one machine is superior to another because it has a better efficiency alone, or a better power-factor alone, or a greater maximum torque (sometimes called pull-out). The reason for this caution is that usually any one particular characteristic can be favored at the expense of others. For example, high efficiency may be obtained at the expense of low starting torque and high starting current, by putting insufficient resistance in the bars and rings of a squirrel-cage rotor. Also, a high starting and maximum torque may be obtained at the expense of low power-factor and low efficiency by decreasing the number of turns in the stator winding, which increases the magnetic field and hence increases the magnetizing current and the iron loss. Also the power-factor may be somewhat improved by cutting down the air-gap, or clearance between the stator and rotor; but this means that a much smaller bearing wear will wipe out this clearance entirely. Further instances could be given which emphasize the fact that when the performance of motors are compared all of the characteristics must be considered or an erroneous conclusion may be drawn.

A. M. Dudley in *The Electrical Journal.*

Ontario Municipal Electrical Association

The Secretary's Report

To the Officers and Members of the Ontario Municipal Electric Association.

GENTLEMEN :—

Our last Annual Meeting was held at the King Edward Hotel, Toronto, on 19th and 20th January, 1927, and while the attendance at our Association meetings was not all that we might have expected, yet the general attendance at the Convention of the two Associations exceeded in point of numbers and in interest that of any previous meeting.

The Summer Convention was held at the Clifton House, Niagara Falls, and was also very largely attended, and we believe gave an opportunity not only for a very pleasant outing and much enjoyment for the delegates, but also an opportunity for the acquiring of information along the lines of Public Ownership, development, both as applied to the power houses at Niagara Falls and Queenston, but also in respect to the new Welland Canal.

Through the kindness of Mayor H. P. Stephens, of Niagara Falls, a trip was arranged to look over the development of the new Welland Canal, and this was taken advantage of by a great many of the delegates present, to, I believe, the advantage of all, to have an opportunity of inspecting this great work.

The speeches at both the Annual Convention as well as the Summer Convention, were of a high order, and the amusements offered were exceptionally attractive, entertaining and amusing.

During the past year there have been many things that have engaged the attention of your Executive, some of which I may be permitted to mention as briefly as possible.

Immediately following the Annual Meeting, the question of the Export Tax on Power was again brought to the attention of the Executive, and while, as you will remember, we have been perfectly in accord with the export tax on any new kind of power to be exported, it has been our policy to carry out any contracts entered into previous to this, and we have contended that the municipalities should not be penalized for the carrying out of a contract of the Ontario Power Commission for which the municipalities receive no direct benefit.

Representatives of your Association had several conferences with members of the Government in respect to this and they expressed themselves as quite in accord with their points, and while no permanent arrangement has been entered into as yet, we have the satisfaction of knowing that we have not been called upon to pay this tax, which would cost some $125,000 per annum.

At the time of our last Annual Meeting it was understood that certain interests were endeavouring to renew an old charter in connection with the Georgian Bay Canal, which seemed to have for its main object the exploitation of power in connection with the proposed development, and when this matter came up before the Federal Government, representatives of your Association felt it imperative that direct action be taken

to save this power for the people of Ontario. Several journeys were made to Ottawa, representatives were sent to the Government of Canada, the municipalities were asked to urge upon the Government of Canada the necessity of disallowing the request of the promoters of this project, and it must be gratifying to the members of our Association to know that we had almost unanimous response from all parts of the Province of Ontario, and that because of this refusing the renewal of this charter, this water power is now available for the people of the two Provinces.

From time to time various matters have been brought up by the municipalities in all parts of Ontario where difficulties or misunderstandings have arisen and your Executive have done everything in their power to assist in the further progress and the development of the distribution of Hydro Electric energy throughout Ontario.

It might be at this point interesting to note the growth of the Hydro movement, which started originally with seven municipalities, and which in 1910 had a distribution of some 700 horse-power, which has grown during the passing years to such an extent that 526 municipalities are now partners in the Hydro Project, in addition to which some 55 municipalities are being served in the Central Ontario district, which is owned by the Government, giving a total of 581, distributing over one million horse power, the largest organization of this kind in the world.

During the past year contracts have been entered into with the Hydro Electric Power Commission for the purchase of additional supplies of power being developed in the Province of Quebec, which will be delivered to the Hydro Electric Power Commission at very advantageous rates, which will have the effect of releasing large quantities of power distributing from Niagara for use in Western Ontario.

The report of the Pension and Retirement Committee will be presented to the Annual Meeting, and while the details will not be outlined in the report, these will be dealt with separately by a member of the Committee, and will appear in the minutes. This work, which has been going on for the past two years, has entailed a large number of meetings and a great deal of exhaustive study and comparison with various systems in operation elsewhere, and the methods of different companies, and while it has taken a considerable time I believe the favourable rates and benefits secured have more than justified the delay.

For some time past the City of Sault Ste. Marie and the adjoining district have been served with electric power by a private company, and realizing the enormous advantages enjoyed by the municipalities interested in the Hydro System, requests were made by the Mayor and Council of the Soo for information in respect to development there that might serve their municipality along the same lines as the municipalities in Lower Ontario.

Reports were prepared and presented by the Hydro Electric Power Commission and your Association was asked to send representatives to the Soo to explain the advantages

enjoyed by the municipalities already partners in the Hydro project. The Hydro By-law was defeated at the vote taken on New Year's Day, and there has been considerable publicity given to this in the press of the different cities, and it may be well that you be given a synopsis of the campaign, results, and the interests affected.

As you know Hydro distribution is just the one story-power at cost, and this was fully explained by members of our Association and representatives of the Hydro Electric Power Commission, and on the other hand we had the private interests, with headquarters in Chicago, backed up by the powerful influences which have been fighting Hydro from the very beginning, and which is allied with those responsible for the water steal from the Great Lakes. On the Saturday night previous to the campaign, a special edition of one of the Soo newspapers was gotten out, and we are told, distributed on Sunday afternoon, notifying the people that in the event of the Hydro By-law being defeated one company would construct a plant worth some twelve million dollars, which would employ a very great number of people, and another company intended to add an extension to their plant of one million dollars. This news, coming at the last moment when there was not opportunity of refuting their arguments, had the effect to the defeat of the Hydro By-law. To illustrate the vindictive attitude of some of our opponents, it is only necessary to remind you of the leaflet sent out to all Commissions in Ontario, postmarked January 13th, at Sault Ste. Marie, in which, with a cunning worthy of a better cause, has warped and distorted the facts in an endeavor to secure sympathy for the poor private interests which, owing to the Hydro presentation of facts were compelled first to amend the Great Lakes agreement, second, to put up $25,000 as a guarantee to the Soo that the agreement would be carried out, and lastly, to promise the immediate construction of some thirteen million dollars' worth of additional factories, all of which can be credited to Hydro influence.

You will have seen from the press that certain individuals have seen fit to attack certain members of the Commission, which is simply a repetition of the attacks and persecutions employed against our former chief, the late Sir Adam Beck, and while we may resent these, yet the Hydro has been such a successful undertaking that we can afford to disregard these attacks and only consider them as representative of the men using such unworthy methods, but when the statement is made, as has been made, that the estimates of the engineers of the Hydro Electric Power Commission are inaccurate and misleading, then we do feel that it is time for the Hydro Electric Commission of Ontario to enter an official denial and give their united support to the engineering staff, which has been of such enormous advantage in the building up and carrying out of this great enterprise.

For several years past the proposed development of the St. Lawrence has been of considerable importance to the people of Ontario. Resolutions have been passed by our Association,

petitions forwarded from municipalities, and memorials presented by delegations, urging the Government to approve of the plans prepared by the Hydro Electric Power Commission and filed with the Government for the development of these waters for the benefit of the people of this Province.

This matter has been dealt with from various angles, and we find now there is a direct likelihood of the Lower St. Lawrence being developed by private interests in the Province of Quebec, while on the other hand certain interests in the United States have made, which no doubt seems to them, generous proposals for the development of that part of the St. Lawrence lying between the United States and the Province of Ontario.

The time is surely here when, by united effort on the part of the Provincial Government, the Hydro Electric Power Commission of Ontario, and the Province of Ontario, it should be shown to all those interested in the St. Lawrence, that the people of Ontario claim all power rights in these boundary waters and intend to develop them for the benefit of all the people in the Hydro Electric System, which has been of such great advantage to the Province of Ontario.

Minutes of Annual Meeting

The meeting was called to order at 2.40 p.m., President C. A. Maguire in the chair.

The minutes of the last Annual Meeting were distributed to all members present, and it was moved by Mr. Fred Harp, Brantford, seconded by Mr. J. W. Oakes, Guelph, that the minutes be taken as read. Carried.

The Secretary then presented his report and it was moved by Mr. Gover, Orillia, seconded by Mr. George Wright, Toronto, that the Secretary's report be adopted. Carried.

The Treasurer's report was presented, giving an itemized statement of receipts and expenditures and showing a balance of $269.32 in the bank, and this was adopted, on motion of Mr. Fred Harp, Brantford, seconded by Mr. J. W. Oakes, Guelph.

President C. A. Maguire then addressed the meeting, reports of which appeared in the daily papers and of which the following is a brief synopsis.

In his presidential address, Mr. Maguire briefly traced the progress of the Hydro movement. He spoke of the seven municipalities taking less than 700 horse-power in 1910, to 581 municipalities in the Hydro co-partnership to-day, consuming over 1,000-000 h.p.

Referring to the Sault campaign, Mr. Maguire read extracts from the Sault newspaper, and explained how misleading reports had been sent out. The interests Hydro had to fight at the Sault were, no doubt, the same interests, though, perhaps, not the same individuals, who were concerned about taking water at Chicago from the Great Lakes.

He indicated the animosity that was shown toward Hydro by the Sault Star, by showing a re-print of the edition carrying attacks upon Hydro by the private company. This

issue came out January 13, two weeks after the campaign was over. The one satisfactory outcome of the fight, said Mr. Maguire, was that the Sault had a promise from the company that it would spend twelve to fifteen million dollars in extending its works. He hoped this was more than a mere election promise. On the other hand, he re-affirmed the stand of the Hydro Electric Power Commission that the Great Lakes Power Co., had no water power rights on the Montreal River.

Mr. Maguire then spoke of rural extensions, and said that 1,000 miles of rural transmission lines were being built each year, and the Hydro Electric Power Commission was now serving 78 per cent. of the population of the Province.

The following Committees presented their reports :—

Resolutions—

Fred Newman, Picton.
Mayor H. P. Stephens, Niagara Falls.

Nominating Committee—

Col. Green, St. Thomas.
Carl Kranz, Kitchener.
Fred Newman, Picton.
H. P. Stephens, Niagara Falls.
J. F. Craig, Barrie.
J. H. Shepherd, Windsor.

Report of the Nominating Committee was presented recommending the following officers and directors for 1928 :—

Officers—

President—C. A. Maguire, Toronto
Vice-President—Willoughby Ellis, Hamilton.
Vice-President—W. K. Sanderson St. Thomas.
Vice-President—Fred Newman, Picton.
Vice-President—August Lang, Kitchener.

Directors—

T. W. McFarland, London.
Jas. H. Shepherd, Windsor.
H. P. Stephens, Niagara Falls.
J. F. Craig, Barrie.
Fred Harp, Brantford.
W. B. Reynolds, Brockville.
J. G. Archibald, Woodstock.

Following that the President thanked the members on behalf of himself and the officers elected, for their continued faith in the Directors of the Association's affairs. Mr. August Lang, Kitchener, congratulated the President on his election, and urged the co-operation of all Commissioners in the works of the Association, as he felt the President was entitled to undivided support and loyal co-operation of every Commissioner in the Public Utilities Commissions in the Province.

Mayor Smith, of Chatham, expressed his pleasure at the way the business of the Annual Meeting and work of the Association had been attended to, and said he would be glad to give his fullest support to the work of the organization.

Commissioner H. O. Hawkes, of Galt introduced the matter of Municipal Insurance to be handled by the Hydro Commission, and Mr. George Wright, Toronto, and Mr. W. Ellis, of Hamilton, explained that each municipality had a right to handle its own insurance in the way that seemed best to them, and at the time this was brought up two years ago, it had been considered inadvisable to

go into the matter further as the Hydro Electric Power Commission's jurisdiction did not extend into this.

Mayor H. P. Stephens, Niagara Falls, spoke of the wonderful progress of Hydro and of the wonderful affect it had had in the municipalities of Ontario, also dealing briefly with the work of the organization, urging united effort on the part of all Commissioners and introduced the following resolution :—

Moved by Mayor H. P. Stephens, Niagara Falls, seconded by Fred Newman, Picton :—

That in view of the recent attacks made by interested parties, reflecting on members of our Association and members of the staff of the Hydro Electric Power Commission, in connection with the recent campaign, in Sault Ste. Marie, we desire to place ourselves on record as having the utmost confidence in those representatives who, at the request of the Mayor and Council of Sault Ste. Marie, took part in this campaign, and we feel that any reflection on their sincerity, good faith or public service records is entirely unwarranted and without justification in fact.

Mr. P. W. Ellis, Chairman Toronto Transportation Commission and Toronto Hydro Commission, congratulated the Association on the excellent work that it had done during the past years, and he said it was of extreme importance to the municipalities to have such a valuable organization continually on the alert at all times for the advancement of Hydro development and betterment of Municipal conditions. Mr. Ellis gave a brief résumé of conditions in the city of Toronto, following the introduction of Hydro, showing a great reduction in price of electricity during that time, and the wonderful increase in consumption, due to the reduced prices, which had made it possible for householders to take advantage of the many labour-saving devices introduced in recent years.

Commissioner J. W. Oakes, of Guelph, congratulated the organization on its efforts and expressed particular pleasure at the address given by President Maguire, which he said was one of the clearest, most straightforward and informative addresses he had every listened to at any public meeting. Mr. Oakes also excited the envy of some of the other members at the progress Guelph was making when he stated that just before Christmas the Guelph Commission had returned cheques to over 4,000 customers, amounting in all to some $35,000.00 despite the fact that Guelph rates are as low as any in Ontario.

Mr. Newman, of Picton, also explained that Picton was in the same position, having also returned cheques for a considerable amount to their customers at this time.

Mr. Jas. H. Shepherd, Windsor, who was the Mayor when the Hydro contract was signed in Windsor, said it gave him great pleasure to look back on the remarkable success that had attended Hydro development in Windsor, where their power load had grown from 2,000 h.p. to 21,000 h.p., and where the rates are less than one-quarter to-day than they were at the beginning.

Mr. Calder, of Hanover, also expressed the satisfaction of his muni-

cipality with Hydro conditions in their district, and the excellent assistance rendered to them at all times by the staff of the Hydro Commission.

Miss Mary Grant, of London Township, also spoke briefly of the success which had attended distribution of Hydro power in the townships around the city of London.

Mayor Armstrong, of Hanover, concurred with the statement of Commissioner Calder, and said their experience with the Hydro and the distribution of electric power had been a most satisfactory one.

Commissioner Anderson, Chairman of the Niagara Falls Commission, was delighted with the annual meeting, which he considered of great benefit, where all Commissioners could come together on a common ground with an opportunity of expressing their local and personal views, and while they had always received fair and equitable treatment, it was valuable to all Commissioners to have an opportunity of getting together on occasions such as this to exchange experiences.

Commissioner C. Kranz, of Kitchener, was pleased to be at this meeting, and as Commissioner for many years standing, he felt that troubles would arise from time to time which meetings of this kind gave an opportunity to discuss and straighten out, and the experience at Kitchener with the Hydro System had been one of entire satisfaction, giving the municipality opportunities that would not have been possible in any other system.

Commissioner T. W. McFarland, of London, who had been unable to attend meetings the last couple of years owing to press of business, was given a wonderful reception by the delegates and expressed his pleasure at being able to attend again, and outlined some of the work being done by the city of London, which has always been one of the most successful Hydro centres in Ontario.

The following resolution was introduced :—

Moved by Fred Newman, Picton, seconded by H. P. Stephens, Niagara Falls :—

THAT we view with satisfaction the sympathetic consideration shown by the Federal Government to the deputation from the Ontario Associated Boards of Trade which recently presented resolutions asking for the early development of the St. Lawrence waterway.

WHEREAS the undeveloped water powers in the St. Lawrence River in Ontario Constitute the most desirable large source of supply for electric energy at low cost yet undeveloped.

THEREFORE be it resolved that the Ontario Municipal Electric Association, representing over 500 municipalities in this Province, respectfully urges the Dominion Government to proceed without unnecessary delay to make appropriate arrangements for the early development of electric power from the St. Lawrence River in Ontario, and we renew and reaffirm our previous resolutions, petitions and memorials that such development be under the administration and control of the Government of Ontario in behalf of the municipalities of this Province.

The Secretary read a report of the Pension and Retirement Committee to be presented at the general meeting on Thursday the 19th.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

The Executive Committee of this Association held a meeting at the office of the Hydro-Electric Power Commission of Ontario on Wednesday April 4, 1928. The meeting was called to order at 2.15 p.m., by the Chairman, Mr. J. G. Archibald; other members present being Messrs., V. B. Coleman, J. R. McLinden, R. J. Smith, T. J. Hannigan, O. H. Scott, J. E. B. Phelps, A. W. J. Stewart, D. J. McAuley, H. G. Hall, V. S. McIntyre and S. R. A. Clement.

It was moved by Mr. V. S. McIntyre and seconded by Mr. O. H. Scott, THAT the minutes of the last Covention and of the previous Executive Committee meeting, as published in the Bulletin, be adopted. Carried.

The only business arising out of the former meetings was a Resolution passed at the Convention asking the Executive Committee to recommend to the Hydro-Electric Power Commission of Ontario, through the Ontario Municipal Electrical Association, the inclusion in the proposed new building of the Commission of an auditorium large enough for meetings of the Associations.

It was moved by Mr. O. H. Scott, and seconded by Mr. J. R. McLinden, THAT in accordance with the request of the Convention of the Associations, the Executive Committee concurs in its resolution and that the same be passed on for action. Carried.

Mr. V. S. McIntyre reported briefly on the work of the Pension Committee, and advised that as a result of the Committee's work definite action would be taken in the very near future.

Mr. A. W. J. Stewart, Chairman of the Convention Committee presented a report of that Committee outlining plans for the Summer Convention, which is outlined in the following:

It is suggested that the afternoon of Wednesday, June 13th, should be given over to golf, baseball and a ladies' bridge party, and that the Convention dinner be the only entertainment provided for that evening.

On Thursday afternoon it is proposed to have a trip over a section of the Welland Canal including that portion between Thorold and Pt. Weller. It is proposed to hold a dance on that evening.

The Committee asked for an allowance of \$150.00 for prizes in addition to a further allowance of \$50.00 for ladies' prizes and \$100.00 for an orchestra and entertainment for the meals and dance. It also asked that return post cards be sent out with the Convention notices to be used in making hotel reservation.

Mr. Stewart having moved the adoption of this report, it was seconded by Mr. D. J. McAuley and Carried.

Mr. O. H. Scott, Chairman, Papers Committee, presented suggestions he had received for papers for the Convention. After discussing these it was moved by Mr. V. S. McIntyre and seconded by Mr. J. E. B. Phelps, THAT papers be presented on the following subjects:

(1) Merchandising, Use of Appliances.

(2) Guelph System of meter reading.

(3) Business psychology.

(4) Gatineau line.

(5) Modern street lighting practice.

(6) Pole line construction.

(7) Primary distribution by cable, and after authors of these papers have been consulted that the Secretary and the Chairman of the Papers Committee arrange for the days on which they will be presented. Carried.

After discussing the question of speakers for the Convention dinner and luncheons, Mr. T. J. Hannigan agreed that these would be obtained by the Ontario Municipal Electrical Association.

It was also suggested that the Secretary arrange for an assistant from one of the Niagara Falls' offices to look after registration, sale of meal tickets and information bureau during the Convention.

The question of membership was then discussed and the various district directors advised of the utilities in their districts that had not renewed membership for this year.

There being no further business the meeting adjourned at 4 p.m.

Sutherland-Buck

We wish to entend our congratulations to Mr. F. B. Sutherland, Superintendent, Beamsville Rural Power District, on his marriage to Miss Addie M. Buck, daughter of Mr. and Mrs. J. Wellington Buck of Beamsville. The wedding was celebrated on March 17, 1928, after which the happy couple took an extended trip to New York, Atlantic City and Pittsburg.

HYDRO NEWS ITEMS

Central Ontario System

The new temporary 3,000 kv-a. station in Oshawa is now ready for service. This will at present serve the Feldspar Glass Co., and the Oshawa Street Railway sub-station.

* * * *

An additional 100 kv-a. transformer has been installed in the Colborne Station to take care of the additional load in that town and the Colborne R.P.D.

* * * *

The construction of a new line of approximately five miles in Cobourg Rural District to serve the hamlet of Baltimore and farmers of the district is now approved.

* * * *

Work instructions have been issued for the construction of a line seven miles long to serve Chemong Park and Bridgenoth in Peterborough Rural District. This district enjoys the lowest rural rates in the Province of Ontario.

* * * *

The Municipality of Lindsay which was one of the old Central Ontario System towns, has purchased its distribution system from the Commission and in future will operate as a cost municipality. Mr. Walter Reesor, previously employed by the Commission, is continuing as Manager for the town. Lindsay is fortunate in having such an able manager as Mr. Reesor, to launch the town on its new venture.

Niagara System

A Wine Company in Beamsville Rural Power District has contracted for 50 h.p. to operate equipment for the chilling of wine.

* * * *

A Gravel Company near Paris is contemplating opening a new property where 350 h.p. would be required for its operation.

* * * *

Billing offices are being opened at Norwich, Aylmer, Dorchester and Delaware to take care of business in the rural power districts in those vicinities.

* * * *

Woodstock Public Utilities Commission has placed an order for 3-250 kv-a. 26400/13200-2300/575 volt transformers to be installed in their No. 2 sub-station. These will be in service about June 1st.

* * * *

A Rubber Company has taken over and is remodelling a factory building in Woodstock for its use. This plant will take approximately 400 h.p., which will be stepped-down from 13,200 volts to 550 volts at the premises.

* * * *

On account of the steady increase in load in the town of Amherstburg and Amherstburg Rural Power District, the Commission has replaced the 3-100 kv-a. indoor transformers with 3-250 kv-a. outdoor. This

makes the total capacity of this station 1050 kv-a.

* * * *

The electrically-driven low-head pumps of the Tilbury Drainage Scheme were put in service this month. The Commission in charge of the drainage scheme consider the operation to be highly satisfactory. So far only one of the 60 h.p. units has been operated; this being all that has been required up to the present.

* * * *

The Commission has replaced the 75 kv-a., 3-phase, outdoor transformer at Harrow by a 150 kv-a. This has been necessary on account of the increased load in Harrow Rural Power District. This district commenced operation about two years ago and it is expected that this Season will show even greater expansion in load.

* * * *

The police village of Bridgeport has been supplied for a number of years as part of the Kitchener system. On January 28, 1928, by an almost unanimous vote the electors authorized the purchase of the system and the signing of a contract for power with this Commission. The village began operating its own system March 1, 1928.

List of Electrical Devices, Material and Fittings

Approved by the Hydro-Electric Power Commission of Ontario in March, 1928.

Appliances

ALTORFER BROS. COMPANY, Peoria, Ill.

Electric washing machine, "A.B.C. Spinner," Model 60.

* * * *

CANADA COMPUTING COMPANY, LIMITED, 52 Burriss Street, Hamilton, Ont.

Electrically-operated meat slicing machine.

* * * *

CANADIAN WESTINGHOUSE COMPANY, LIMITED, Hamilton, Ont.

"Sol-Lux Windo-Flood" lighting fixture.

* * * *

COLLINS NEVER-FAIL PRODUCTS LIMITED, Hamilton, Ont.

Electrically-heated incubators Model Nos. 300, 300M; brooders, Model Nos. 159, 160, 161; "Economy" heater, Model No. 50.

* * * *

THE GUELPH STOVE CO., LIMITED, Guelph, Ont.

"Acme" electric cooking ranges. Cabinet type, Style Nos. 421 and 320; Low oven, Style Nos. 42, A. 32.

* * * *

MANTON BROTHERS, 105 Elizabeth Street, Toronto.

Sheet Heaters for attachment to printing press.

THE SCHOLL MANUFACTURING COMPANY, LIMITED, (Submittor), 112 Adelaide St. E., Toronto.

THE SCHOLL MANUFACTURING COMPANY, (Mfr.), 213 W. Schiller Street, Chicago, Ill.

"Dr. Scholl's Zino-pads" electric display sign.

* * * *

WELLMADE ELECTRIC MFG. CO., Torrington, Conn.

"Wellmade" Portable Electric Soldering Iron.

* * * *

VILAS OIL BURNERS LIMITED, Cowansville, P.Q.

Electrical equipment for oil-burning furnaces.

* * * *

*ACME ELECTRIC WELDING CO., 5615-17 Pacific Blvd., Los Angeles, Calif.

Electric Welding Machines. Types A. B. C. D.

* * * *

*CHICAGO HARDWARE FOUNDRY CO., North Chicago, Ill.

"Sani-Dri" Machines.

* * * *

*SIGNAL ENGINEERING & MFG. CO., 154 W. 14th St., New York, N.Y.

Non-automatic fire alarm systems (As listed on Underwriters' Laboratories card dated January 17, 1928).

* * * *

Fittings

PORCELAIN PRODUCTS, INC., P.O. Box 197, Findlay, Ohio.

Porcelain bushings and tubes. "PP", "F", "FEDCO", "GP."

Porcelain knobs and single two and and three-wire cleats. "PP", "F", "FEDCO", "GP."

* * * *

Switches

*SIGNAL ENGINEERING & MFG. CO., 154 W., 14th St., New York, N.Y.

Automatic Switches—Magnetically-operated type. (As listed on Underwriters' Laboratories card dated Sept. 9, 1927).

Signal Appliances, Type AT-1.

* * * *

*STANDARD ELECTRIC MFG. CO., 925-41 Wrightwood Ave., Chicago, Ill.

Flush Switches.

Push type, single pole, Cat. No. 5001.

Double pole, Cat. No. 5002, Three way, Cat. No. 5003.

Toggle Type, single-pole, Cat. No. 6001, Three-way, Cat. No. 6003.

* * * *

Portable Lighting Devices

JOHN KAY COMPANY, LIMITED, 15 King St., E., Toronto.

Portable electric lamps.

* * * *

*These cards are under the Underwriters' Laboratories re-examination or label services.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Galt Electric Utility

THE story of Galt Electric Utility is very closely related to the life of the late Robert Elliott. After assisting with the installation, Mr. Elliott became the Superintendent and continued as such and in other capacities until his death, at which time he was Manager. A brief reference was made to Mr. Elliott in the February Bulletin, but here we wish more particularly to outline the growth of the System with which he had so much to do.

Prior to August, 1886, the only illumination in the homes and streets of Galt was provided by coal oil. On that date the first electric street light was turned on, when quite a crowd of citizens gathered to witness the event.

It was in 1886 that a small company was formed for the purpose of producing electricity. A contract was obtained to operate 30 arc street lights during a period of 10 years. Twenty of these lights were located on the hills and went out at midnight, while 10 located in the valley burned all night. For this service the company received $1.00 per lamp per week. They purchased a generator of about 75 h.p. capacity from the Royal Electric Company of Montreal, and had it installed in what was known as Old Dumfries Mill, on the site of the present Armory. The generator was driven by an overshot water wheel fed by an old raceway from the Main Street pond. The water in the pond was controlled by gates in what was known as Rodd's dam and to insure sufficient water in the pond for a night's requirements it was necessary to open the gates in the pond in the morning, it taking 12 to 15 hours to fill the pond. At times the water supply was not sufficient to carry the full street lighting load, and at such times the power supply was reduced accordingly. The overshot water wheel not proving satisfactory, a Kennedy turbine was installed. This worked all right

CONTENTS

Vol. XV **No. 5**

May, 1928

	Page
Galt Electric Utility - - - -	145
Application of Hydro-Electric Power to Farm Work - - - -	150
Totalizing and Remote Metering Methods - - - - -	158
Some Interesting Factors in Fuse Design - - - - -	172
Hydro News Items - - -	177

when there was water, but as the load increased it became necessary to install a boiler and steam engine to supplement the power provided by the turbine.

The original installation was not a financial success and in 1888 the Company sold out its holdings to the Galt Gas Light Company. The latter Company undertook selling electricity for house lighting and the first building to be so lit was a hotel built about that time.

In 1890 the Galt Gas Light Company purchased the old Blain Mill located at the dam which had discontinued manufacturing flour. Generating equipment was installed here which was driven by water wheels and steam engines, and remained the electrical generating station until 1911, when Galt began receiving electricity through the Hydro-Electric Power Commission of Ontario.

The City purchased the distribution system of the Galt Gas Light Company in 1910. At that time there were 450 consumers, there being only two power users. The rates to lighting users were then 12 cents per kilowatt-hour, with a 10 per cent. prompt payment discount and a monthly meter rental of 25 cents. The power users paid 8 cents per

Old Dumfries Mill, which stood on the site of the present Armory, where electricity was first generated in Galt

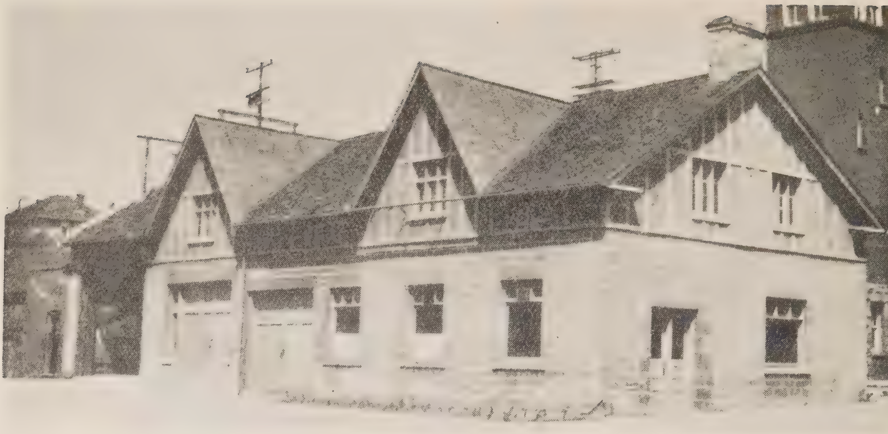
The Old Blain Mill, used as a generating station from 1890 to 1911

kilowatt-hour, less 10 per cent., and a monthly meter rental and Commercial consumers 13c. per kw-hr.

The City's contract with the Hydro-Electric Power Commission was for 1200 h.p. Power was first delivered under this contract in March, 1911, and was used for street lighting. Domestic and commercial service was changed over to Hydro in June of that year. The first bill for power from the Hydro was for 93.9 h.p. By October of that year the Galt load had grown to 335 h.p.

To establish the transformer station to distribute the Hydro power at a more central location, the City purchased a building formerly used as a fire hall and school and had it remodelled. The original installation in this building consisted of 3-150 kv-a. transformers and necessary switching and feeder equipment.

The records of the succeeding years show a steady growth in the number of consumers served and load taken and we find that during the year 1915, Galt had exceeded the amount of power to be taken as provided in the contract. It soon became apparent that the building used for a transformer station was being fast outgrown



First distributing station of Galt Public Utilities Commission, which was used from 1911 to 1922

and that larger quarters must be provided.

In July, 1922, the Galt Public Utilities opened its new building in

Office and main distributing station building of Galt Public Utilities Commission

which provision was made for growth of load for some time to come. At this time we find the City served not only by its central transformer station but by two other sub-stations. The average load is shown to have increased to over 3600 h.p., or more than three times the original contract.

And so the story goes on until in the year just closed, 1927, we find the average load of the City of Galt to have exceeded 5500 h.p. In addition to power used for municipal purposes about 4,000 lighting and power users are receiving service. The total value of the electric utility is approximately $754,300, and the yearly revenue has grown to $249,500. The value of the debentures of the Galt Public Utilities Commission outstanding is $333,900, while the accumulated reserves amount to $229,400. The only source of revenue of the Galt Public Utilities Commission for the electric utility has been from the sale of electricity and supplying street lighting service, yet while maintaining a very satisfactory financial condition service has been supplied to lighting users at less than 2 cents per kilowatt-hour for a number of years while the charges for power service have been equally low.

The responsibility of the Galt Electric Utility is invested in the Galt Public Utilities Commission, which for the present year is composed of Messrs. H. O. Hawke, Chairman, Geo. Hancock, W. A. Dixon, and R. W. Wilkinson, Commissioners, Dr. W. S. McKay, Mayor, and A. B. Scott, Secretary-Treasurer.

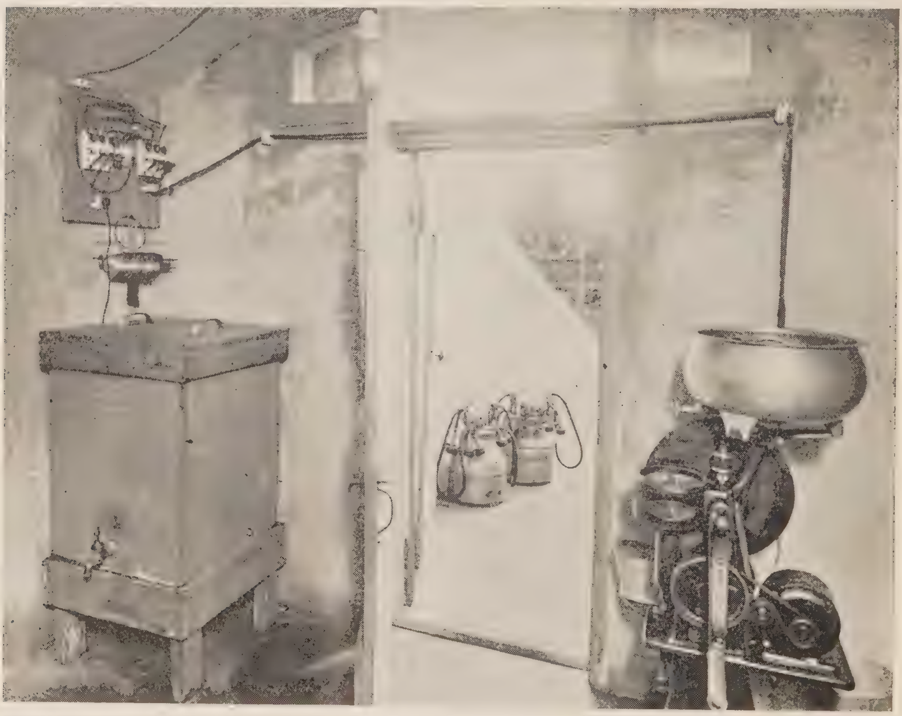
Public Office and Show Room, Galt Public Utilities Commission

Application of Hydro-Electric Power to Farm Work

Article No. 13

Farm Dairy and Dairy Industries

THE dairy farm without power is seriously handicapped unless sufficient help is available for milking and handling of the product of the place. The regularity of milking interferes with the other work of the farm at times during the year, especially during seeding and harvesting seasons. This application of power on the farm is usually a welcome service as it permits the farmer and his help, with the exception



A cream separator with ¼ horse-power motor belted direct to farm size cream separator, a form of drive that is very convenient. The slippage in starting is provided for by a tightener with spring control. A 30 gallon water heater is shown behind the door and the milking machine units in the passageway ready to take to the barn.

The arrangement of drive for the cream separator. The ½ horse-power motor on the shelf belted to counter-shaft with slip belt arrangement with tightener is a form of drive commonly used, very effective and reliable.

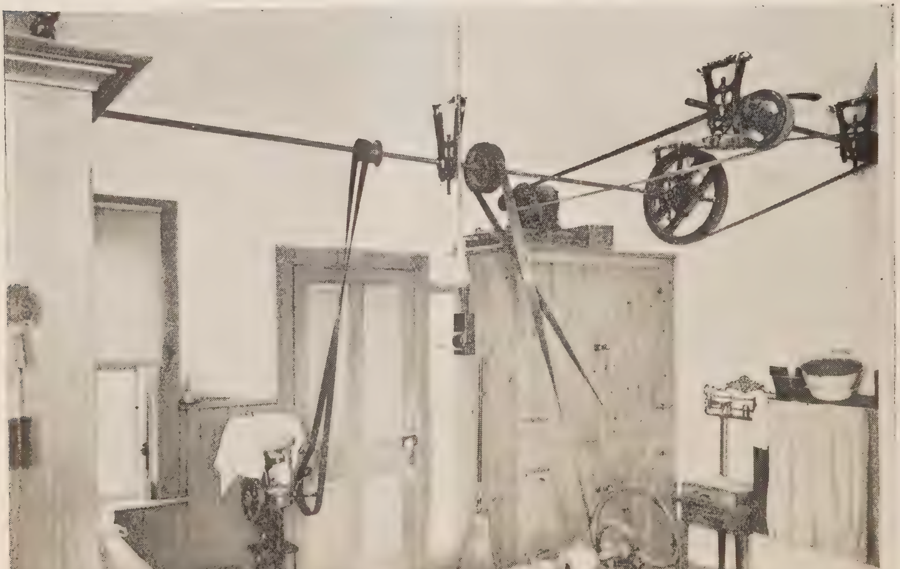
The cream separator with ¼ horse-power motor on shelf, the slip-pulley jack mounted on the ceiling provides for slip in starting. The motor comes to full speed in a few seconds. The cream separator takes a minute.

of perhaps but one, to continue their field work of "Making hay while the sun shines."

The possible applications on the dairy farm include power drive for the milking machine, the cream separator, the water service and agitating the milk while cooling; the heating of water for cleansing containers and utensils; the washing and bottling machines and the refrigerator.

A few farms in the Province have undertaken the production of certified milk for children and sick persons, in districts adjacent to large centres. On these electric power is almost imperative as some of the process

See Next Page



See Next Page

Illustration at top of preceding page.

The 1 horse-power motor on a shelf not shown provides the drive for the equipment in this combination of pumphouse workshop and dairy. The pulley used for driving the cream separator is also used for driving a grindstone outside during harvest season for sharpening implement knives and other harvesting tools.

Illustration at bottom of preceding page.

A ½ horse-power motor mounted on a cabinet in the summer kitchen on a Waterloo County farm with a line shafting on the ceiling provides a means for driving a cream separator and a belted type washing machine, as well as a churn not shown in the picture.

should be automatic or semi-automatic.

A variety of drives for cream separators is shown in the accompanying cuts including those from line shafting, from the motor belted direct, and from the motor belted to a separator jack shaft, either on the separator on a separate mounting. On a large number of dairy farms the dairy is included with the pump in pump-house in a separate structure and on some a work shop is also in this building. A line shafting driven by a motor serves all the equipment in the building making a convenient arrangement and permitting additions or enlargements of uses without serious changes.

Milking machines are found in use on many Hydro served farms and with care and cleanliness they appear to be successfully used, although in some districts, its use is restricted or

Milking by Hydro electric power on a farm in the Norwich district, the progressive vacuum type of machine being in use. The drive is through line shafting from the 5 horsepower motor centrally located to serve other power-using machinery in the barn, a chopper, a root pulper and a cutting box.

See Next Page

See Next Page

Illustration at top of preceding page.

The milk cooling, aerating and bottling equipment and entrance to the refrigeration room on a farm in Waterloo County. Specially treated milk is produced for children and the sick in the Town of Waterloo and City of Kitchener.

Illustration at bottom of preceding page.

The bottle washing machine with its individual motor, bottles in cases and hot water tanks on the same farm. Cleanliness of the containers is only one of many essentials in public supply of this kind.

prohibited by the control authorities, apparently on account of failure to give the necessary attention to cleansing. Reports of results where care is given and bacteria count regularly made would indicate better results by machine than by hand milking. Three kinds of machines are found in use that is, the progressive vacuum type, the vacuum pressure type and

The pasteurization tank on the same farm, the stirring equipment of whi· is driven by the ¼ horsepower motor shown on the end of the tank.

Hydro electric power in rural districts provides a most convenient drive for cheese and butter factories. The cuts show the interior of a factory in the Norwich Rural Power District. The receiving room with the motor mounted on a concrete foundation are shown in the one, the cheese vats with stirring mechanism, the churn, working table and a separator beyond the churn in the other. This factory operates part time on butter production and part of the time on cheese.

the straight vacuum type. Power requirements vary from 1/2 to 2 horsepower.

In dairy industries the use of power is essential as only limited help is available in most of these plants. The use

of Hydro-Electric power of course does not eliminate the necessity for steam as hot water or steam must be used for sterilization and cleansing. The usual uses included pumping of water, whey or buttermilk, the stirring of milk in cheese vats, the operating of separators for whey or milk, the drive for the churn and refrigeration in some, which should be used in practically all. Fans for the cooling rooms would improve the conditions of storage and decrease losses from mould in cheese and tend to improve the quality of butter.

Owing to the variety of combination there is quite a range between maximum and minimum power requirements. We have set out below, however, a tabulation of approximate power requirements and consumption. An application of the rate in the district, and hours of run would give the cost of operation of the different combinations referred to.

To Serve	Size of Motor	Power Consumption per hour of run in Kw.
Cream Separator alone (Farm size)	¼ to ½ h.p.	0.2 to 0.4
Cream Separator and pump (Farm size)	½ to 1 h.p.	0.4 to 0.75
Cream Separator pump and farm workshop	1 to 2 h.p.	0.75 to 1.5
Milking Machines	½ to 2 h.p.	0.4 to 1.5
Cheese and butter factories (refrigeration separate)	3 to 7½ h.p.	2.25 to 5.75
Refrigeration—1 ton plant	5 h.p.	3.75
" —2 " "	7½ h.p.	5.75

Totalizing and Remote Metering Methods

By H. S. Baker, Meter Supervisor, H. E. P. C. of Ont,

(Read before the New England Branch of the National Electric Light Association at Boston, February 7, 1928)

IN the following it is intended to describe and illustrate some details of the multi-element totalizing graphic meters as developed by the writer and also to outline some methods of remote metering and totalizing of power which have been used in various places.

The moving weight principle used in these multi-element graphic meters has been in use since 1912, but has not been taken up seriously as a manufacturing proposition.

The writer's experience with the moving weight principle as compared to the spring principle is as follows;—

(1) Greater permanency of zero and of calibration.

(2) Greater sensitivity to small fluctuations of load.

(3) Possibility of using more magnified scales.

(4) Inherent straight line relation between load and deflection.

Fig. 1. shows method of supporting the moving coils on vertical push rods which stand on knife edges, and are steadied at the top by three point crow foot plates. This method of support ensures permanent mechanical relation between moving and stationary coils. The male members of the knife edge hinges are all attached to the balance lever. This ensures constancy in effective lengths of lever arms regardless of the exact relative position of knife edges in seatings. In making satisfactory knife edges and seatings, and also crow foot points and seatings there are a few points that are necessary to observe for successful use of this form of hinge. The steel knife edges and seatings are of tool steel hardened. The knife edges are made dead sharp and then very slightly blunted to avoid chipping. The seatings must be absolutely free from scratches and must not have a sharper curvature at the bottom of the "V" than the edges or points have. Soap should be applied to the steel surface during quenching to avoid excessive scaling, and the surfaces should be burnished after quenching.

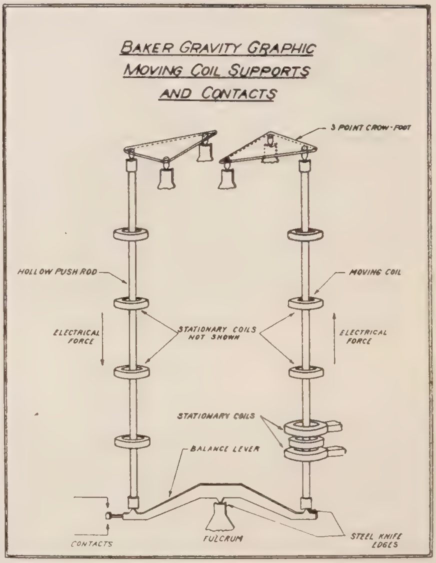


Fig. 1

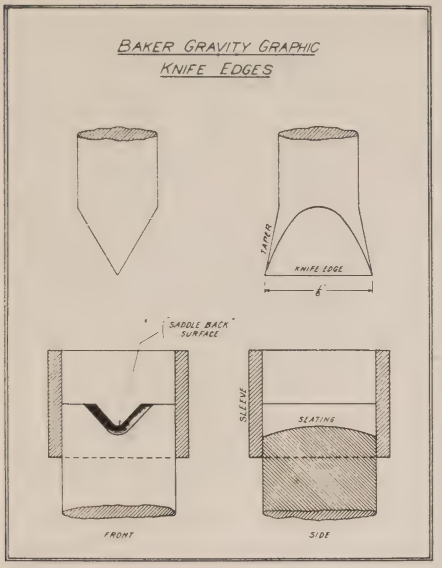


Fig. 2

Fig. 2. shows a form of knife edge and seating which are easily made and easily polished after hardening. The points of application of side thrust (if any) are the end points of the knife edge itself and are on the centre line of relative motion of the edge and seating. A 12 element meter equipped with these knife edges and crow feet was found to register on its chart the application and removal of one half inch of No. 26 copper wire to a point 5 inches from the centre fulcrum. This torque was one 390th (1–390) of one inch-ounce, or less than one 4000th (1–4000) of full load torque.

Fig. 3. shows roughly the arrangement of the moving weight upon a weight track which is attached to the main balance lever. The weight runs on grooved wheels, not shown in Fig. 3. The drag link which communicates the motion of the pen to the moving weight is as shown except that its line of force should be slightly above the level of the knife edges. This is to avoid any component of the drag link thrust, tending to hold a contact shut, and so causing overshooting of the pen in approaching its true point on the chart.

Coarse adjustments to calibration are made by varying W_1, the moving weight, while fine adjustments are made by shifting W_2 along on the drag link. W_2 takes the form of two knurled nuts jammed together. The zero adjustment weight is not shown but is attached to the balance lever and can be shifted to right or left. The unstabilizing weight (not shown) is attached to the balance lever and can be shifted vertically. The moving system may be in unstable balance before the phosphor bronze leading in wires are connected to the moving coils and yet be too stable after connecting

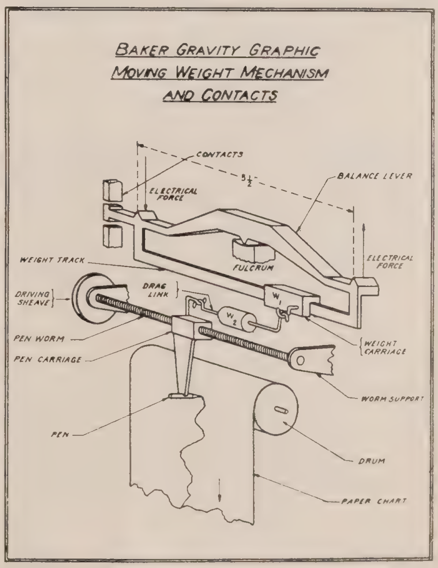


Fig. 3

them in. This can be set right again by raising the unstabilizing weight. It is important that the leading in wires be resilient so that they do not take a permanent set if slightly disturbed. A change of set however, would only mean a resetting of the zero weight. Referring to Fig 3. it will be seen that, if the electrical force is greater than that represented by the position of W_1, or the pen, then the lower contact will close. This starts up the pen operating motor and pen worm in a direction which will move the pen and W_1, and correct the balance and allow the contact to open and stop the motor.

Fig. 4. shows the wiring diagram of the pen driving motor and meter contacts. The motor is of the squirrel cage induction type running on ball bearings, and belted to the sheave on the pen worm by a helical steel wire spring belt.

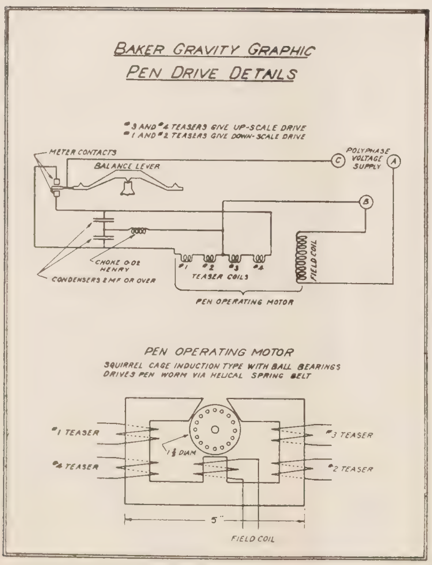


Fig. 4

The source of power for this motor is a three phase 110 volt supply. One winding of the motor is continually alive while two other windings are intermittently livened up through the meter contacts as shown, to give forward or backward rotation. The combination of condensers and choke coil shown has been used for years on a meter that (on account of switch board hum) would not give sensitive charts on previously used methods. The choke coil is made as low in impedance as possible without freezing the contacts together upon closure to the condensers. Upon rattling of the contact the condensers discharge into the motor for a very short time after the contacts have been parted due to rattling. Many combinations of condensers and resistances have been applied to this particular contact problem but have been abandoned in favor of resistances alone. The use of the choke coil, however, seems to make it practical to make the condenser of more benefit than harm. This motor takes about 30 watts and delivers about one 10,000th horse power hence its efficiency is only slightly on the plus side of zero. Its free speed is only about one-quarter of synchronous speed. There may be room for improved design here although the motor delivers enough power for the purpose.

Fig. 5 shows the method of depressing the zero by various amounts, to points beyond the lower edge of the chart paper. By doing this it is practical to use a very magnified chart and whenever the pen threatens to go off the chart at the upper side, then one more weight is dropped on to its hook and the pen goes immediately

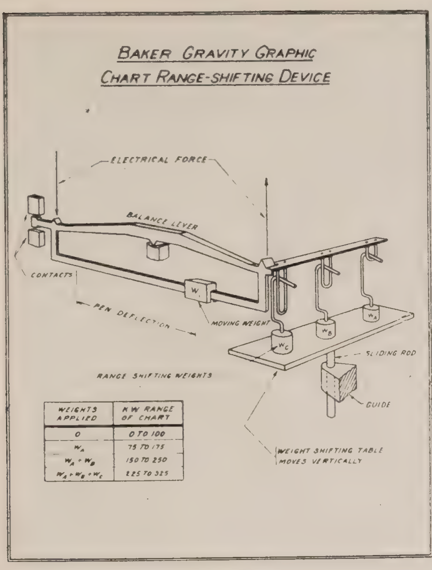


Fig. 5

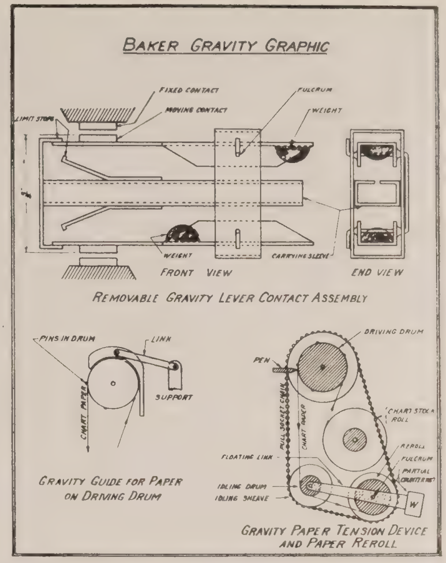


Fig. 6

down to a point near the lower edge of the chart and starts again on its upward course with lots of room to spare. The reverse happens during periods when the load is decreasing. Each change weight is equivalent to about three-quarters of the spread of the chart hence there is plenty of overlap on the various ranges of the meter.

Fig. 6. shows details of the main contacts of the meter. The two moving contacts are carried on small levers which carry counter-weights that determine the contact pressure. When the pen has very nearly reached its balance point there is very little force available for closing contacts. At this time (even if the pen is approaching zero or approaching a dead steady load condition) there is always present a slight amount of swinging of the balance lever. Hence it will be seen that during a swing which causes closure of a contact, the contact pressure jumps instantly to normal value and holds this correct value till contact is broken.

With a spring contact a gentle approach means very light contact

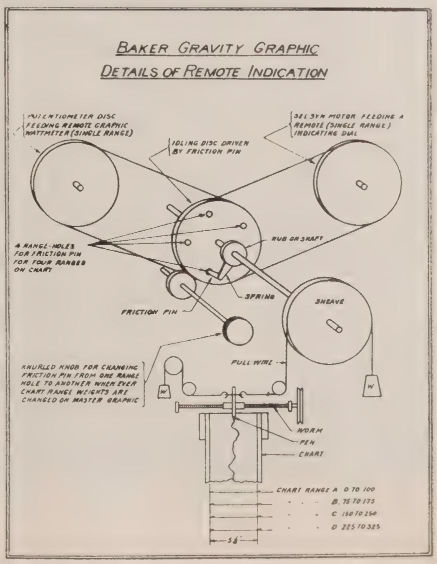


Fig. 7

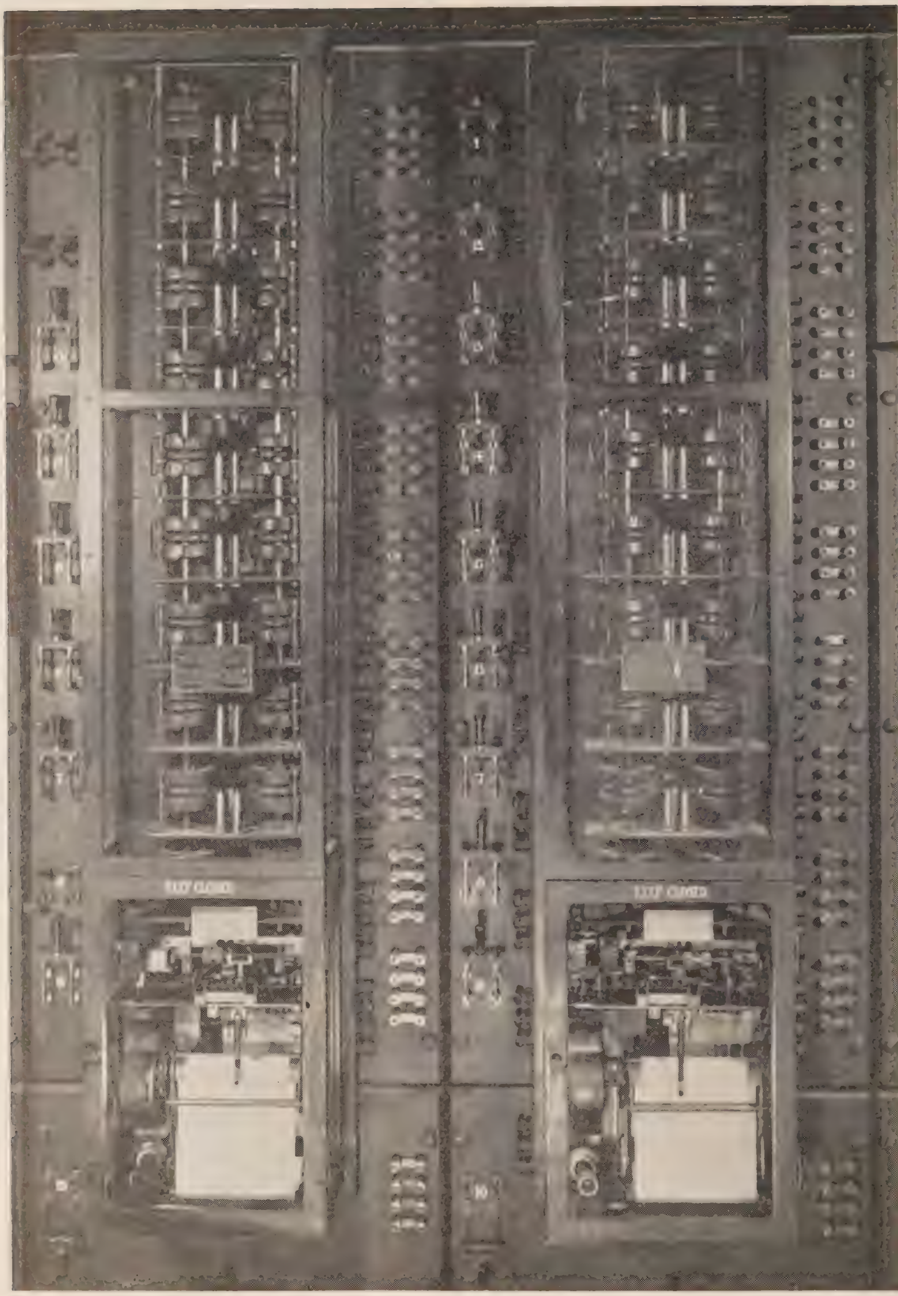


Fig. 8. Two multi-element, gravity, graphic watt-meters installed in Queenston Generating Station.

at first then the contact pressure may become greater than necessary which shortens the duration of contact and sometimes results in a tendency towards sluggishness of pen action. The contract pressures used with gravity lever contacts range from one 200th of an ounce for single element meters up to one 20th ounce in multi-element totalizers. If the meter shows a tendency to overshoot, then the contact pressure can be increased which shortens the duration of contact impulses when the pen is nearing its point of balance. Dash pots in connection with these contacts are generally not necessary for single element meters but are used on multi-element total meters.

The contact assembly is easily removed for inspection by just sliding it off its supporting prong.

Fig. 6. also shows the gravity paper guide, being a curved keeper holding the paper to the drum by its weight. Wrinkles in the paper can pass under without stopping the clock, which drives the paper drum.

The gravity paper tension and re-roll is also shown and has given better average satisfaction in actual service than some other forms tried.

Fig. 7. shows pull wire and grooved pulleys which drive the Selsyn motor that operates the indicating dial. A similar pulley drives the sliding contact potentiometer which feeds a remote graphic wattmeter six miles distant, over two No. 19 wires in telephone cable.

Both the indicating dial and the remote wattmeter are single range instruments and Fig 7 shows the device which introduces a definite angular slip in this mechanical trans-

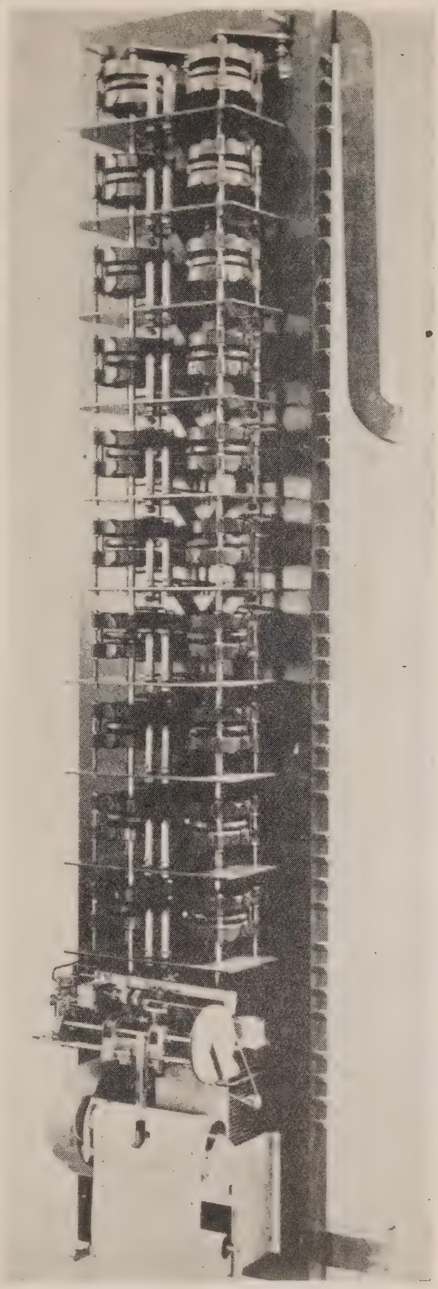


Fig. 9. Multi-element, gravity, gra p hi c Watt-meter, case removed.

mission whenever the range weights are changed on the master meter.

Thus when the pen was at say the 95 per. cent point on the first range

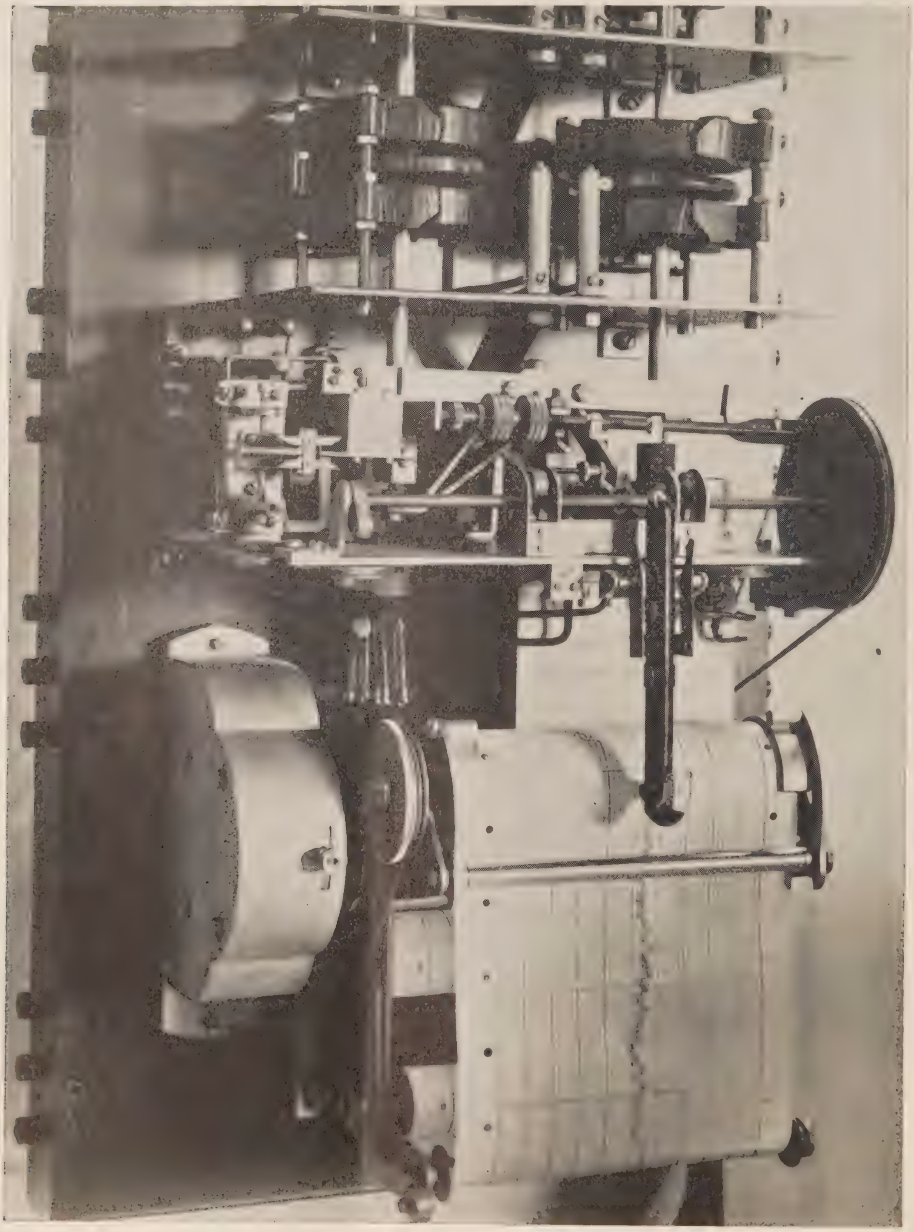


Fig. 10. Close up of Baker Type, Total kw. Meter.

Fig. 11. Total indicating dial driven from different total kw. meters.

and going up, the operator would add one range weight, bringing the pen back to the 15 per cent. point. At the same time he would slip the friction pin one hole so that the grooved pulleys would not be carried back this 75 per cent., but travel on up scale as the load increased.

Fig. 8, shows photo of installation of two of these multi-element gravity graphics.

Fig. 9, shows one in the shop with the case removed.

Fig. 10, shows a close up of the above. The micrometer adjustment for spacing of stationary coils can be seen. This is not necessary in the case of the wattmeter for equalization of elements, but is necessary in the case of the reactive component meter where the potential circuit resistances (3 in star) must be alike. This adjustment is however, used for convenience in the wattmeter too.

Fig. 11, shows large indicating dial with two hands driven by two Selsyn motors from different total kilowatt meters.

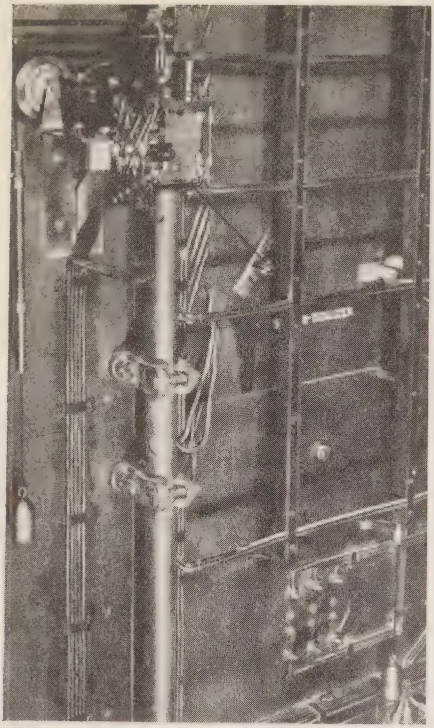


Fig. 12. Selsyn drive to indicating dial.

Fig. 12, shows pull wires and pulleys and Selsyn transmitter feeding receiver at indicating dial.

Fig. 13, shows one of these multi-element graphics with 24 polyphase elements that has been giving good service since 1914. There are 48 moving coils carried on 8 vertical push rods. The only trouble with this meter has been due to an inadequate style of pen driving motor which is a commutator type of clock winding motor. This has to be renewed every few years.

This meter has been checked several times since 1914 and on only one occasion was the calibration changed. This change amounted to 3/10 of one percent on only one of the four ranges. The other three have not been altered and are still in accurate calibration.

Following is a tabulation of witness checks on a 12 element gravity graphic which shows remarkable permanency of calibration.

MONTHLY WITNESS CHECKS ON 12 ELEMENT GRAVITY TOTAL GRAPHIC WATT-METER.

Date	True Kw.	Kw. by Graphic	% Error Minus
Nov. 24, 1916.	57863	57656	0.36
	65161	65020	0.21
	72249	72158	0.12
	78269	78194	0.10
Dec. 29, 1916.	Ditto	57655	0.36
		64843	0.49
		71956	0.40
		77992	0.36
Jan. 26, 1917.	57949	57722	0.39
	65242	65038	0.31
	72367	72102	0.37
	78398	78215	0.23

Date	True Kw.	Kw. by Graphic	% Error Minus
Feb. 23, 1917.	58018	57688	0.57
	65328	65150	0.27
	72412	72261	0.21
	78447	78295	0.23
Mar. 30, 1917.	Ditto	57753	0.46
		65088	0.37
		72097	0.44
		78155	0.41
Apr. 28, 1927.	57941	57777	0.28
	65211	65043	0.26
	72315	72134	0.23
	78342	78272	0.09
May 31, 1917.	57930	57599	0.57
	65227	64862	0.56
	72322	72099	0.31
	78349	78135	0.27
June 29, 1917.	Ditto	57578	0.61
		64888	0.52
		71922	0.56
		77905	0.57

Fig. 14. Shows a graphic frequency meter using the moving weight principle. The torque element is a flyball governor, driven by a synchronous motor. This meter has no electrical contacts, but uses forward and back friction drive.

Fig. 15. Shows a radically different method of totalizing of various loads. This system comes under the head of remote or local totalizing. It is the Lincoln Meter Company's Thermal-Converter system used as transmitters delivering thermocouple voltages proportional to the watts fed through the current and potential circuits.

The figure shows a number of couples connected positively in the "couple circuit," and also an equal number of negative couples. Two heaters are shown which we will call the plus and the minus heaters, acting respectively on the plus and minus couples.

It can be shown that the difference of heating at any instant of time, is proportional to the watts represented by the instantaneous values of current and potential at that time, hence the average difference of heating is the average watts for all conditions of wave form and power factor.

The diagram shows one heater receiving the sum of two instantaneous currents, which measure respectively the instantaneous main current

and the instantaneous main potential. The other heater receives the *difference* of these two currents. Some very simple algebra will show that the

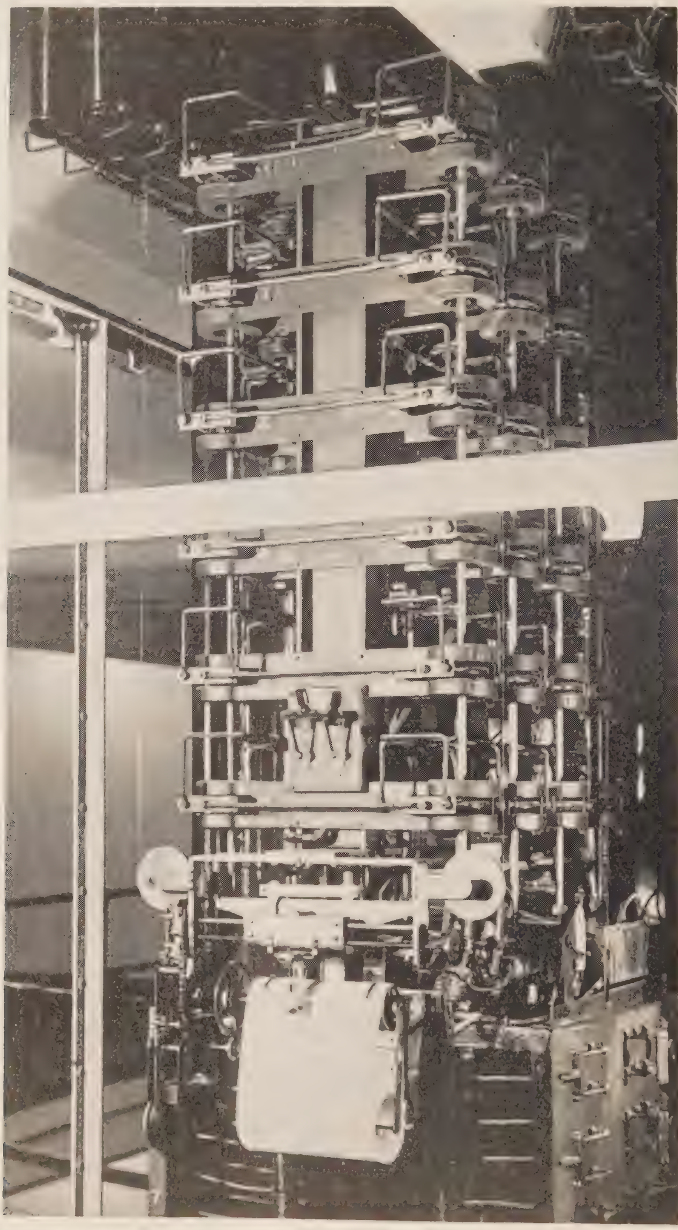


Fig. 13. Multi-element, graphic, kw. meter having 24 polyphase elements, in service since 1914.

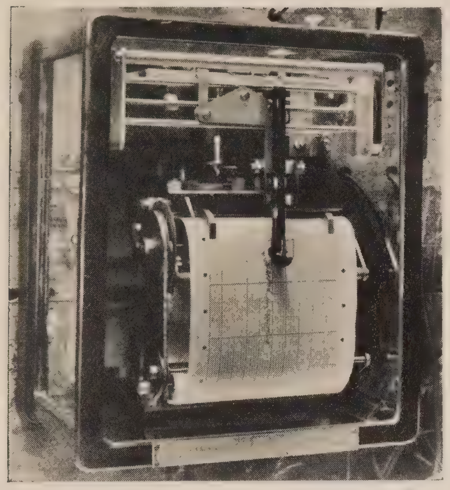


Fig. 14. 60 cycle graphic frequency meter, Baker Synchronous type.

difference of heating, which is measured by the difference of the squares of these two composite currents, is equal to a constant times the product of the instantaneous main current and potential, as required.

Of course, there are two of these single phase elements in one polyphase transmitter, with the two thermocouple circuits in series feeding the d.c. ouput terminals. The complete thermocouple circuit has about 28 ohms resistance and delivers 20 millivolts for rated full load on the transmitter. These transmitters can be connected to read kilowatts, or reactive kilovolt-amperes, and can be connected to add to or subtract from the total load.

The two heaters in one single phase element are accurately balanced against each other to give zero millivolts on potential alone. This is done by shunting off a part of the current from the stronger heater. They are again bucked to zero millivolts on current alone by varying a tap on a slide wire connecting the two right hand ends of the heaters as shown in the figure.

Calibration is now effected by shunting a small part of the current from the tap shown on the potential transformer, to the tap on the above slide wire connecting the heaters. This shunt is of zero temperature, co-efficient, as are the heaters. The amount of copper resistance in series with the heaters is made small enough that its variation with temperature is not serious.

The couples and heaters are enclosed in a thermal conducting shield which ensures that changes of room temperature will affect both heaters alike. Equalizing plates are also provided to nullify the effect of conducted heat along heater connections.

Fig. 15 Also shows the connections from the transmitters to the receiving

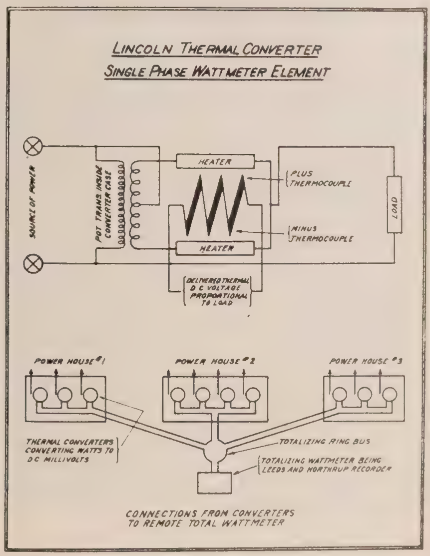


Fig. 15.

total instrument, which is a Leeds and Northup recorder. These recorders draw zero current from the line when the pen has reached the balance condition, hence the true generated voltage is measured independent of varying line resistance.

If it is required to register (at the totalizing point) the individual loads of the several power stations, then separate recorders can receive the thermal voltages from the several stations, and a local bridge circuit (not requiring potentiometer current regulation) can totalize the various sub totals into one grand total on another recorder.

The transmitters have a logarithmic time characteristic, taking about 12 seconds to travel nine-tenths of the way to steady voltage value. This is sufficiently rapid to keep ahead of the receiving recorders.

Following is a tabulation of installations all of which have given satisfactory performance except one, in which open overhead telephone wires without bypass filters were used through a disturbing district as conductors connecting transmitters to totalizing receiver. The disturbance in this case showed up occasionally as false kicks superimposed on the normal chart. Lead covered cable or style B twisted pair is to be preferred in most cases to open separate telephone wires.

TABLE OF LINCOLN THERMAL INSTALLATIONS

Installation	Date of Installation	Conductor miles	Conductor ohms	Nature of conductors	Number of transmitters	Receiver ohms	Accuracy	Troubles
A	Sep. 1926	25.	530	No. 16 in supervisory cable.	16	1200	Checks to 1% of sum of 4 Watt meters.	Few poor joints and broken insulation.
B	Apr. 1926	3.5	74	No. 16 Style B twisted.	3	....	"Satisfactory to customer"	None reported
C		2.0	10	2 No. 10 open separate without filters.	4	....	"not satisfactory to customer who expects ½% of full scale.	Disturbances received on open wires show on receiver.
D	Aug. 1926.	Short	..		4	....	Not reported	None reported

E	July, 1926	0.5	12	No. 16 Style B twisted.	2	....	Satisfactory	None reported
F	Sept. 1927	2.5	53	No. 12 Style B twisted.	3	....	Not reported	None reported
G	Oct. 1927	Short	..		2	....	Not reported	None reported
H	New	1.5	63	No. 16 Style B twisted.	3	....	Not reported but placed duplicate order	None reported
I	New	10.0	198	3 No. 19 in Cables.	4	....	Not reported	None reported
J	New	2.5	20	2 No. 16 in cable.	5	....	Not reported	Operation reported very satisfactory.

To be continued in June number.

Type of Truck used for Service work in Rural Power Districts.

Some Interesting Factors In Fuse Design

By G. R. Brown, Engineering Dept., Bridgeport Works, General Electric Company.

THE earliest attempts to provide an automatic interrupting device for the protection of circuits and connected apparatus resulted in the development of the fuse as we know it today. Its primal form consisted of a short length of copper wire of smaller cross-section than the conductor used in the circuit. When made of this material, however, it failed to give the desired protection because it permitted excessive heating in the remainder of the circuit before fusion occurred. This led, naturally, to the use of materials of lower melting points than copper; lead and lead alloy elements of larger cross-section being substituted for the copper wire of small diameter. The evolution of the modern fuse has demanded consideration of many factors, and much experimentation has been necessary to produce a device so simple and so effective as the one now employed in the protection of low-voltage circuits.

As is well known, the principle involved in all fuses is that a short length of metal may be raised to its melting point if a sufficiently high current is made to pass through it. Under ordinary conditions, it may be said that for a given cross-section and length of this metal there will be a definite temperature rise for a certain current strength. In practice, however, the temperature rise in a fuse does not bear the definite relationship to the current that might at first be expected, for the reason that it is very greatly affected by certain variable conditions. The principal of these are: the ability of the fuse to throw off the heat, which, so far as the fuse link or wire itself is concerned, is largely governed by its superficial dimensions; the position of the fuse links; the conditions of the surrounding atmosphere, as to whether it is in motion or quiet, which is a still more uncertain factor than either of those before mentioned; and whether the fuse link itself is in contact with any body whose ability to absorb the heat developed is greater than that of air. It will be seen that a condition may exist wherein the rate of radiation or loss of heat by the fuse equals the rate at which the heat is developed. There will then exist a state of equilibrium and, should the temperature be just below that at which the metal softens, the fuse will be carrying its maximum current.

If the current should now be increased slightly, the rate of development of the heat becomes more rapid than the rate of dissipation, with the result that the temperature increases gradually; and in time the melting point will be reached. This increase in the current value will constitute an overload since it is in excess of the maximum current that the fuse will carry. With a further increase in

current the balance is further disturbed, the rate of radiation remaining practically the same while the rate of development of heat is more rapid than before, with the result that the time required to bring the mass to the melting point is considerable less; or, in other words, the time factor for any given overload becomes rapidly less as the current increases, the time factor being the time required to bring the fuse to its melting point from the moment of the increase of current above the normal current-carrying capacity of the fuse. The two most important of the variable factors which affect the rate of radiation of the fuse are probably the exposure to draft and contact with adjacent bodies. In a draft the heat is more rapidly taken up by the passing air than if it were quiet, while by contact with a body of such material as porcelain or metal, whose rate of absorption of heat is greater than that of air, an equilibrium may be established and maintained until the body becomes heated. Under such conditions it will be found that a fuse requires a much longer time to reach the melting point.

Another feature of uncertainty, of much the same nature, is the effect of the fuse terminals in establishing this time factor. If the fuse metal is connected to very massive terminals with large thermal capacity, the time factor will be materially increased. If, however, the terminals are small and light so that they possess but comparatively small heat-conducting ability, they can have little effect in changing it. To correct these defects, then, it becomes necessary to fix all the otherwise variable factors in order to secure a device the melting point of which for any given overload is practically constant.

It has been found, however, that in fuses above certain sizes, particularly those adapted to carrying heavy currents, trouble is frequently incurred when the fuses are subjected to a severe overcharge of current. This is due to the fact that the volume of metal volatilized by the action of the current and requiring dissipation is so great that there is likely to be a severe explosion when the sudden expansion of the comparatively large volume of metallic vapor occurs. Several ways have been tried in seeking to overcome this difficulty, among them being the use of an alloy of high conductivity, by which means the cross-section of the link would be materially reduced; but it has been found that all alloys of high conductivity, such as alloys of tin, copper and the like, whatever the bulk of the metal, vaporize with what may be called explosive action. On the other hand, metals of less conductivity, such as lead, cadmium or bismuth form eutectic alloys which, within certain limits as to bulk, can be transformed from metal to vapor almost instantly, and without undue disturbance; but in fuses of large capacity a single fuse link of lead or lead alloy must necessarily be of large cross-sectional area and of considerable bulk, and is therefore apt to vaporize with an explosive action for the reasons mentioned.

Fuse metals of high conductivity, too, have a comparatively high melting point; and if the circuit becomes loaded to the full capacity of the fuse,

the enclosing case must either dissipate this high temperature or become excessively hot. So the middle ground is taken as conforming to the best practice, and zinc or zinc alloys are used almost universally for the fusible element in enclosed fuses. Even with pure zinc, the pressures exerted inside the fibre casings, under short-circuit conditions, sometimes measure as high as 250 lb. per sq. in. Screened vents permit the escape of this gas without the emission of flame.

There are many grades of commercial zinc and as many differing results dependent upon their use in enclosed fuses. The melting away of the pure zinc from a fuse strip may leave a network or bridge of impurities having a still higher melting point and capable of carrying current of considerable volume. Therefore, pure zinc, or zinc alloyed with lead and cadmium only, gives a more dependable performance. The element must also be annealed, after rolling, to remove strain hardness. Fuse strips or links of dead-soft zinc will withstand the greatest amount of alternate heating and cooling, expanding and contracting, with the least signs of distress due to crystallization. The failure of a fuse while carrying less than its rated load may often be attributed to hard fuse metal.

It is found in practice that the link oxidizes when the current slowly increases beyond the maximum carrying capacity of the fuse; and if a critical temperature just below its melting point be maintained for any considerable time, a coating or skin of oxide may become thick enough to support the metal within it, even when the latter has become melted. Thus when a filling of too finely divided arc-suppressing material lies against this oxide-coated link it serves to support the skin and prevent the rupture which should otherwise occur. In order to obviate this serious difficulty, it is necessary that correctly proportioned filler be used, providing sufficient spaces between the particles or lumps to allow the oxide film to break.

Filler is a non-conducting material, chemically inert, preferably in small pellet form (such as slaked lime or plaster of paris) providing a multitude of minute paths or interstices for the escape of the vapor or gas evolved upon the blowing of the fuse links by an excessive current. Another important function of the filling material is to dissipate the heat from the surface of the link by conduction. If the water content of the filler is too great, the effect is to increase the rate of conduction and also the carrying capacity of the fuse. Conversely, if there is insufficient moisture, the small lumps of filler become soft and are easily reduced to powder.

To detect the cessation of usefulness of the fuse in a convenient manner, indicators of many types have been developed. One of the most successful types consists of a high-resistance wire connected in parallel with the fuse element, and having a small portion of its length brought outside the casing at a point covered by the label. A groove made in the fibre tube provides protection from mechanical injury and permits the application of the indicator paste or compound over the wire without interfering with smooth labelling. Current of normal strength passes

through the fuse without affecting the indicator wire, the larger portion of the current being of course carried by the first link because of the high resistance of the small wire. Upon the disruption of the fuse link, the voltage across the fuse terminals is raised and sufficient current passes through the indicator wire to melt it and to fire the indicator compound. This causes a blackened or charred spot to appear on the label showing clearly that the fuse has blown.

Considered even so briefly, the matter of fuse design will be seen to embody far more labor and ingenuity than the extreme simplicity of the device might seem to demand; but, in another sense, the care and cost of the development are abundantly recompensed. *By permission of General Electric Review.*

Notes Re Visitors

On May 7th at the last meeting of the Niagara Peninsula Branch of the Engineering Institute of Canada, Sir Henry Thornton paid a visit to our Queenston plant. He asked a number of questions, but said very little during the course of his inspection. In his evening address, however, while touching on engineering achievements, he referred to the huge engineering accomplishments of the Ancients. The principal difficulties in the way of these tasks, he said, consisted in moving large objects in to planes and in accurately orienting the structures, and he ventured to comment that after what he had seen today (referring to his visit to Queenston) that the accomplishment of the Hydro-Electric Power Commission at Queenston far surpassed the works of the Ancients, particularly when comparing the motive of public service which animated the Commission with that of self-aggrandizement at the expense of enormous effort and loss of life in the case of the rulers of Ancient Egypt.

* * * * *

Professor J. R. Ainsworth Davis, representing the Public School Employment Bureau of England, paid a visit to the office of the Commission on Wednesday, May 23rd., and discussed the possibilities for employment of English public school boys in electrical and other engineering works in Canada. Professor Davis is on a six weeks visit to Canada, as the guest of the Ontario Government to set up contacts for the placement of English public school boys in Canada.

On Thursday, May 24th, Professor Ainsworth Davis paid a visit to Niagara Falls, where he saw the Queenston Power Plant through the courtesy of the Operating Department and other sights of interest in Niagara Falls.

* * * * *

The Wisconsin Legislative Interim Committee on Water Power expressed their desire, and have completed arrangements for a two weeks' visit in Ontario during the next month for the purpose of studying the work of this Commission. This Committee consists of the following members : Senator Harry B. Daggett, West Milwaukee, Chairman; Assemblyman Alvin C. Reis, Madison, Secretary; Arthur F. Stofen, Clerk and Reporter; Senator, Jas. A. Barker,

Antigo, and Assemblymen L. L. Thayler, Birchwood, and Thos. M. Duncan, Milwaukee.

The party proposes to travel by motor bus, entering Ontario at Windsor, on Monday, June 18, 1928, visiting various Hydro towns and their Commissions in Western Ontario, before taking in the eastern and northern sections, going by way of Chatham, London, Stratford, Kitchener, Galt, Guelph, and Preston. From this point the party will proceed to Niagara Falls by way of Hamilton, visiting Hamilton offices and works en route and inspect the works at Niagara Falls including the Queenston plant, Chippawa Canal and the new Welland Canal. They will then proceed to Toronto where they will visit this Commission and its works, as well as those of the Toronto Hydro and the Toronto Transportation Commission. Proceeding eastward the plants of the Central Ontario System will be inspected and a day given over to fishing in the Kawartha Lakes district. The party will then proceed to Midland, visiting the plants on the Severn River and continue through to Collingwood and Owen Sound, returning to Sarnia by the Blue Water Highway, ma king a visit at Goderich.

V. S. McIntyre

Our readers will be pleased to learn of the marriage of Mr. V. S. McIntyre, Manager, Public Utilities Commission, Kitchener, Ontario, to Mrs. F. Kenney, formerly of Toronto. The wedding was celebrated at Knox Presbyterian Church, Toronto, by Rev. J. G. Inkster, on Thursday, April 26, 1928, after which the happy couple left for an extended trip to Hamilton, Niagara Falls, Buffalo and other points. We extend our congratulations to Mr. and Mrs. McIntyre and give them every good wish for the future.

Hydro News Items

Central Ontario System

Tenders are now being received for the erection of a switch-house in connection with the new 1500 kv-a. station which is being built by the municipality of Whitby.

* * * * *

In March, 1926, the Oshawa load was approximately 6300 h.p., and today the load has increased to nearly 9,000 h.p., with an additional 2,000 h.p. in sight in the near future. This remarkable growth indicates the commercial activity which has taken place recently in this city.

* * * * *

The office and part of the factory of the Rose Excelsior mill in the village of Pickering was recently destroyed by fire, and it is expected that this will be replaced by a modern building.

* * * * *

Georgian Bay System

The construction of the distribution system in Beaumauris Rural Power District is progressing favorably. Several new contracts have been signed up over and above the number obtained last Fall, and every effort is being made to be ready for service by June 15th. This district includes a large part of the Muskoka Summer Resort area, and the majority of the Hotels, Summer Residences and Cottages in the vicinity of the distributing lines will receive service. The substation will be located near Bracebridge on the main transmission line to Huntsville, and as several of the larger customers are located on islands in Lake Muskoka, a considerable portion of the distribution system will consist of submarine cable.

* * * * *

Arrangements are being made to complete the construction of the necessary lines so as to give service to Buckskin Rural Power District, located on the Severn River, near the C.P.R. crossing, in June. The substation will be located on the Big Chute-Swift Rapids tie line, and will serve a pumping plant for the C.P. Railway at Buckskin Station, as well as a number of summer cottages on the Severn River.

* * * * *

The construction of distributing lines in Innisfil Rural Power District is progressing favorably. The district will serve farms and summer cottages adjacent to the south-western shore of Lake Simcoe, as well as the hamlets of Churchill, Lefroy, Gilford, and Belle Ewart. It is expected that the summer cottages will receive service by the end of June.

* * * * *

A new substation was completed in Midland and placed in operation during the last week in April for the

purpose of serving the Aberdeen Grain Elevator. Service is given to this customer at 550-volts through a bank of three 200 kv-a. transformers fed off a branch 22,000 volt transmission line. This elevator was formerly equipped with steam drive, and has been completely remodelled for individual electric drive. The initial load will be about 400 h.p.

* * * * *

A contract has been completed for serving the Shelburne Stone Quarry. The three-phase primary lines of the village have been extended and substation changes made with provision for serving an initial load of from 75 to 100 h.p., whereas the ultimate demand of this customer is expected to be about 300 h.p.

* * * * *

Considerable activity concerning rural service has been manifested by prospective consumers in the district west of Uxbridge, particularly in the hamlet of Goodwood and vicinity, and every effort is being made to complete arrangements for either extending lines west from Uxbridge or east from Stouffville to serve the district.

* * * * *

A request for the estimated cost of power and particulars concerning Hydro service has been received from the village of Windermere, in the district of Muskoka. The Commission is making an investigation covering service from a proposed substation at Utterson, which would take care of the requirements for the entire district, including Windermere, Utterson, Port Sydney, and the entire summer resort districts adjacent thereto.

Niagara System

A large gravel plant, capable of producing 50 carloads of washed and sized gravel in a ten-hour day, has recently been completed, adjacent to the town of Paris. Hydro power will be used entirely in the operation of this plant, the contract calling for about 300 horsepower. Both Canadian National and Canadian Pacific railway ridings enter the property.

* * * * *

The Ontario Gypsum Co. is developing a new section of its mine on the property near Lythmore, Haldimand County, and equipment is being installed which will use an additional 150 horsepower in motors.

* * * * *

One of the rock quarries at Hagersville is increasing the capacity of its plant, additional power to the extent of approximately 100 horsepower being required.

* * * * *

An office has been opened in Markham for the operation of Markham and Scarboro Rural Power Districts, Mr. J. C. Burns, formerly Superintendent of the Deseronto system being in charge.

* * * * *

An extension of 18 miles is to be made at an early date in the Ingersoll Rural Power District, to serve 60 rural consumers in West Zorra and East Nissouri Townships.

* * * * *

In the St. Thomas Rural Power District extensions of 13 miles will be made west of Shedden to serve 50 rural consumers, including the hamlets of Iona station and Lawrence station.

Extensions amounting to 15 miles will be made as soon as possible in London Rural Power District, London Township, to serve 45 consumers.

* * * * *

The Exeter rural district will be extended early in the summer by 9.5 miles of line to take care of 30 rural consumers located in Stephen and Usborne Townships.

* * * * *

Construction has been commenced of a line to the village of Bayfield, in the Clinton Rural Power District, to be supplied at 8,000 volts from a substation at Clinton. It is expected that service will be available by the latter part of June.

* * * * *

Preparations are being made for an extension to serve consumers in the north-westerly section of the St. Marys Rural Power District. These are located in Blanchard and Fullarton Townships, and in the hamlets of Woodham, Kirton and Fullarton. Power will be supplied at 8,000 volts from a substation to be installed in the St. Marys High-Tension station.

* * * * *

On account of the increase of work in the Harrow Rural Power District the operation of the system has been placed under a man located at Harrow. Billing of the consumers will be handled by the Amherstburg Rural Power District office as heretofore, which formerly also looked after the operation.

An Asphalt plant located at Cedar Springs, in Blenheim Rural Power District, to supply material for resurfacing of 10 miles of highway is being supplied with power from the lines of this district.

* * * * *

The Public Utilities Commission of Scarboro Township has purchased a building on the Kingston Road, a few doors east of the general township offices. The office staffs of both electrical and waterworks departments are now occupying the new quarters.

* * * * *

The combined loads of the village of Waterdown and the Waterdown Rural Power District having grown beyond the capacity of the local station, the 300 kv-a. 3-phase transformer has been replaced by a bank of 3-250 kv-a. single-phase.

* * * * *

Nipissing System

The Commission has approved the construction of a third development for the Nipissing System at Elliott Chutes, located two or three miles above the present development at Bingham Chute. The total installed capacity will be 1800 h.p. and construction will be undertaken during the coming summer.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

List of Electrical Devices, Material and Fittings

Approved by the Hydro-Electric Power Commission of Ontario in April, 1928.

Appliances

THE ADAMS-BARRE COMPANY, 1242 North High Street, Columbus, Ohio.

"Scioto" Rectifier—Garage type. Model "BT."

* * * *

CANADIAN WESTINGHOUSE COMPANY, LIMITED, Hamilton, Ont.

"Cosy Glow" Air Heaters. Style Nos. 278758, H. 20155.

"Rectox" Portable Rectifiers.

* * * *

J. NELSON DAY, LIMITED (Submitter), 130-132 Yonge St., Toronto, Ont.

THE NATIONAL ELECTRIC HEATING Co., LIMITED (Mfr.), 544 Queen St. E. Toronto, Ont.

Electric Hair Waving Machine.

Electric Hair Dryer "Perfecto."

* * * *

ELECTRIC HEATING CO., LIMITED, 681 Notre Dame Avenue, Winnipeg, Man.

Electric Heaters for Automobiles, "Coldwell."

* * * *

THE FITZGERALD MANUFACTURING COMPANY, TORRINGTON, Conn.

"Star-Rite" Waffle Iron, Cat. Nos. 536, 538.

* * * *

HAMILTON BEACH MFG. CO., Racine, Wisconsin.

Electrically-heated Drink Mixer.

KNIGHT REBOUND CONTROLLERS LIMITED, 752 King Street E., Hamilton, Ont.

Electric heater—circulation type, for attachment to engine block of an automobile.

* * * *

THE SOLEX COMPANY, LIMITED, 4060 St. Lawrence Blvd., Montreal, Que.

Portable display rack for advertising electric lamp bulbs, "Solex."

* * * *

SUPERIOR ELECTRIC, LIMITED, Pembroke, Ont.

Immersion Water Heaters, Cat. Nos. 181 to 195 incl.

* * * *

WAHL MANUFACTURING CO. OF CANADA, 322 Donald St., Winnipeg, Man.

Electrically-operated hair clipper.

* * * *

*AMERICAN FLYER MFG. CO. (Submittor), 2219-39 S. Halsted St., Chicago, Ill.

Toy Transformers (as listed on Underwriters' Laboratories card, dated February 3rd, 1928).

* * * *

*ANDERSON - PITT CORPORATION, THE, 208-11 Goodrich Place, Kansas City, Mo.

Portable Electric Air Heaters of the radiant type, Cat. Nos. 914. 612.

* * * *

*BETTENDORF OIL BURNER CO., 2527 State St., Bettendorf, Ia.

Mechanical Draft Oil Burner with a.c. motor drive.

* * * *

*BURDICK CORPORATION, THE, Milton, Wis.

Portable Therapeutic Equipment (as listed on Underwriters' Laboratories card, dated February 24, 1928).

* * * *

*DAY-BRITE REFLECTOR CO., 703 S. Broadway, St. Louis, Mo.

Show Case Type Electric Fixtures, Cat. Nos. 90, 91, 96, 121, 299, 300, 301

* * * *

*EDISON ELECTRIC APPLIANCE CO., INC., 5600 W. Taylor St., Chicago, Ill.

Cooking and Liquid Heating Appliances—Portable Table Stove, Cat. No. 116E29.

Toasters, Cat. Nos. 115T17, 117T23, 116T24, 127T23, 216T25.

Percolators, Cat. Nos. 114P18, 114P19, 114P20, 114P33, 114P34, 114P35, 114P36, 114P37, 114P38, 114P40, 114P42, 114P45, 114P46, 114P47, 114P48, 114P52, 115P20, 115P34, 115P35, 115P36, 115P39, 115P43, 115P44, 115P45, 115P46, 115P53, 115P54, 116P20, 116P34, 117P39, 144P17, 144P18, 214P39.

Waffle Irons, "Hotpoint" Cat. Nos 116Y53, 116Y85, 116Y112, 117Y112, 146Y53, 146Y85, 156Y112, 157Y112, 216Y112, 246Y112.

Portable Immersion Water Heaters, Cat. Nos. 113W16, 115W16, 115W17.

Table Grills, duplex type, Cat. No. 116G9, triplex type, Cat. No. 116G10.

Teapot, Cat. No. 114K5.

Tea Kettle, Cat. No. 20801.

Marking : Nameplate with catalog number and rating.

* * * *

*PEASE CO., THE, C. G. (Mfr.), 813-821 N. Franklin St., Chicago, Ill.

INSTRUMENTS LIMITED (Submittor) 240 Sparks St., Ottawa, Ont.

Automatic Vertical Blue-printing Machine. "Pease." Type U.

Automatic, Motor-driven, Blue-printing Machines and Dryers.

"Pease Peerless." Pease Sheet Dryer Cat. No. 6500-B.

* * * *

*WELSBAC COMPANY, (Mfr.), Gloucester, N.J.

TORONTO AUTO ACCESSORIES, LIMITED (Submittor), 172 John St., Toronto, Ont.

"Welsbach" Household refrigerating machine.

Marking : "Welsbach", Model "C-100," serial number and name and address of manufacturer on compressor base.

* * * *

*WILSON WELDER & METALS CO., INC. (Mfr.), Wilson Bldg., Hoboken, N.J.

G. D. PETERS' CO., LIMITED (Submittor), New Birks Bldg., Montreal, Que.

Electric Arc Welding Equipment. Type S, Design No. 253W. Design No. 203W.

* * * *

Portable Lighting Devices

MUTUAL SUNSET LAMP MFG. CO., INC., 21-25 East Houston St., New York, N.Y.

Portable Electric Lamps. "M.S.-L.Co." or "M.L.Co."

* * * *

Fittings

ELECTRICAL DEVICES, LIMITED, 855 Bay Street, Toronto, Ont.

Sheet Metal Cabinets.

HALE BROS., 84 St. Antoine St., Montreal, Que.

Pull-off plugs of moulded composition bodies, either flat or round terminal studs "Remax" and "W."

* * * *

LANGLEY MANUFACTURING COMPANY, LIMITED, Granville Island, Vancouver, B.C.

Enclosed Branch Circuit Cutouts.

* * * *

TAYLOR ELECTRIC MANUFACTURING CO., LIMITED, 526 Adelaide St., London, Ont.

Cartridge Fuse Cutout Bases. Main line 0-100 A. 250 V. Cat. Nos. 2530, 25302, 2560, 25602, 25100; 600 V. Cat. Nos. 6030, 6060, 60100, 200, 400 and 600 A.; 250 V. Cat. Nos. 25200, 25400, 25600; 600 V., Cat. Nos. 60200, 60400, 60600.

Marking : Manufacturers' trademark "T" or "Canadian," together with the rating in volts and amperes either stamped in the metal clip or moulded in the porcelain bases.

* * * *

*ARMSTRONG & WHITE, 709 Renshaw Building, Pittsburg, Pa.

Porcelain Receptacles, Cat. Nos. 54, 1174-76 incl., 1184-86 incl., 1683, 50715-16, 61988, 71989.

Marking : "A & W. Inc."

* * * *

ELECTRICAL DEVICES, LIMITED, 855 Bay Street, Toronto, Ont.

Panelboards. Types NTP, 2TP.

* * * *

*THE CUTLER-HAMMER MANUFACTURING CO., Milwaukee, Wis.

Hoistway Limit Switch for Pilot control circuits only.

Marking No. 10315-H-26, name and address of manufacturer, 600 volts on plate attached to cover.

Interlock, electro-mechanical.

Marking No. 10326, name and address of manufacturer, 600 volts on plate attached to cover.

Contact so designed that car control circuit is open unless all hoistway doors are closed. For horizontal sliding doors.

Marking : No. 10327-H-11, name and address of manufacturer. 600 volts maximum, on plate attached to cover.

"C-H" Resistance Appliances (as listed on Underwriters' Laboratories cards, dated August 12th, 1927).

Marking : Nameplate with Bulletin number and rating.

Brake Solenoids for operating mechanical brakes. Bulletin Nos. 10340, 570.

Brake Solenoid-operated valve, designed for remote control. Bulletin No. 10435.

Marking : "C-H" and rating.

Elevator Control Appliances (as listed on Underwriters' Laboratories card, dated August 9th, 1927).

Automatic Switch—Magnetically-operated type (as listed on Underwriters' Laboratories card dated April 10th, 1928.)

Automatic Switches—Fload type (as listed on Underwriters' Laboratories cards, dated December 14th, and December 15th, 1926)

Automatic Switches — Pressure operated type. Bulletin Nos. 10001, 10005, 10004.

Marking : "C-H."

Switches. Push-button switches. "C-H" Bulletin No. 10250, Cat. No. 7066.

Panel type fused starting switches.

Standard squirrel-cage motors; high torque squirrel cage motors.

Bulletin Nos. 9116, 9118.

Drum type reverse switch for high torque squirrel cage motors.

Bulletin Nos. 9405, 9406, 5104, Type AA.

Control Switches. Bulletin No. 11450.

Change-over-switches. Drawing Nos. 54720-H-23A, 54720-H-24A, 54720-H-25A.

* * * *

*KEIL & SON, FRANCIS, INC., 401-25 E. 163rd St., New York, N.Y.

Flush Switches.

Single-pole, Cat. Nos. 32521, 32531, 32561.

Double-pole, Cat. Nos. 32522, 32532, 32562.

Three-way, Cat. Nos. 32523, 32563.

Two-circuit, Cat. No. 32721.

* * * *

Miscellaneous

HALE BROTHERS, 84 St. Antoine St., Montreal, Que.

Cord Sets. "Remax" and "W."

* * * *

*These devices are under the Underwriters' Laboratories re-examination or Label Service.

"Twenty Years After"

A year or two ago a firm of electrical contractors was asked to quote for the overhaul of a theatre installation in Glasgow. As a preliminary, a foreman was sent to make an inspection of the existing wiring. In the course of his investigations he followed a certain run of conduit to where it disappeared into a wall. There the trail ended. He was unable to get to the other side of the wall to find out what was happening there. There was a door nearby, but it was locked, and the key of it was lost. It had never been opened in the memory of anyone, from the manager down to the call-boy.

By this time curiosity was excited. What awful mystery lurked behind that locked door? What dusty horror awaited discovery there? The manager had the door forced.

It proved to be the door of a "bill room," and from the date of the last poster lying there, it had never been used since 1906. No difficulty in ascertaining that—for, in a pendant, a 16 c.p. carbon lamp was burning brightly. Somebody had left the switch on when the room was shut up twenty years before; and for all that time that lamp had bravely done its duty, wasting its brilliance on the desert air of a forgotten room—at 60 watts! . . . The manager, a Scot, of course, was carried fainting from the scene.

History does not relate the make of the lamp, and so some manufacturer loses a record advertisement.—*The Electrical Review.*

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Mr. C. A. Magrath's Letter of Submittal of the Twentieth Annual Report

To His Honour THE HONOURABLE
WILLIAM D. ROSS,
Lieutenant-Governor of Ontario.

MAY IT PLEASE YOUR HONOUR:

The undersigned has the honour to present to your Honour the Twentieth Annual Report of the Hydro-Electric Power Commission of Ontario for the fiscal year ending October 31, 1927.

This Report covers all of the Commission's activities and also embodies the financial statements of the municipal electric utilities operating in conjunction with the various systems of the Commission and supplying electrical service to the people of the Province.

Dealing, as it does, with a multiplicity of activities relating to several electrical systems obtaining power from twenty-two hydro-electrical plants operated by the Commission, supplemented by power purchased from other sources, and recording financial and other data relating to the individual local municipal electric utilities, the Annual Report presents a large amount of statistical information, much of which must, of necessity, be of a summary character.

The financial statements, the statistical data and the general information given, however, are so arranged and presented as to convey a comprehensive outlook on the features of the Commission's operations. Not only does the Report record the progress made during the past year, but it gives, in addition, certain cumulative results for the various periods during which operation has been maintained in the respective municipalities.

During the past year the work of the Hydro-Electric Power Commission has been characterized by steady growth. On the Central Ontario and Trent system and on the Rideau St,.

CONTENTS

Vol. XV **No. 6**

June, 1928

	Page
Mr. C. A. Magrath's Letter of Submittal of the Twentieth Annual Report - - - - - - - -	185
Application of Hydro-Electric Power to Farm Work - - - - - -	201
Totalizing and Remote Metering Methods - - - - - - - -	206
Power System Comparisons - -	212
Hydro News Items - - - -	214

Lawrence and Ottawa systems the increases in load have necessitated arrangements being made for additional supplies of power. To meet these increased demands, the Commission is negotiating a contract with the Gatineau Power Company for a supply of 60-cycle power. Transmission lines are now being constructed to convey power from developments on the Gatineau river to the Niagara system of the Commission, and during the year 1928 this additional power will be available for five systems.

The operation of all the systems has been carried on successfully and without serious trouble. The class of equipment provided in the Commission's generating plants and on its transmission networks, and the care with which it is maintained and operated have enabled the Commission to provide a remarkable continuity of service. This is indicated by the fact that power was never entirely off the Niagara system for a single minute during the year. On the Georgian Bay system the continued combined operation of the various generating plants has been very satisfactory and has resulted in an improved service. On the Central Ontario and Trent system, special attention has been given to the problem of conserving and increasing the flow of streams by the installation of dams and the creation of storage reservoirs.

Cost of Electrical Service Furnished by the Commission

The function of the Commission is not only to use its best endeavours to provide for the people of Ontario, at cost, an adequate and reliable supply of electrical energy, but also to ensure that the cost of that electrical energy to the consumers shall be the minimum consistent with the financial stability of the enterprise. The success that has been attained in the accomplishment of the latter object may be appreciated from the fact that, whereas, according to a recent statement by an accredited authority in the United States,* the average cost of electricity to the domestic consumer in the United States, in 1927, exceeded seven cents per kilowatt-hour, the corresponding cost in Ontario, in municipalities served by the Hydro-Electric Power Commission—as shown by the figures given in Statement "D," of this Report—was, for 1927, less than two cents per kilowatt hour. Statement "D" indicates also that rates for commercial light and industrial power service in Ontario are similarly low.

*Consult, *Electrical World*, New York, January 7, 1928.

Respecting the cost to the ultimate consumer of electrical service furnished to Ontario municipalities by the Commission, the following facts are of interest :

More than eighty per cent. of the electrical energy utilized for domestic service is sold in municipalities where the average charge to consumers of this class is less than two cents per kilowatt-hour.

More than eighty per cent. of the electrical energy utilized for commercial light service is sold in municipalities where the average charge to consumers of this class is less than three cents per kilowatt-hour.

More than seventy per cent. of the electrical power distributed by municipal systems and utilized for power service is sold in municipalities where the average charge to consumers is less than twenty-five dollars per horsepower per year.

In each of the above cases the consumers' cost quoted is inclusive of all charges.

Growth in Load

The following tabulation Table No. 1, shows the growth in load in the various systems during the year.

Financial Summaries

It will be observed that the financial statements embodied in this Report are presented in two main divisions, namely, a division—Section IX—which deals with the operations of the Commission in the generation, transformation and transmission of electrical energy *to the co-operating municipalities*, and a division—Section X—which deals with the various operations of the municipal electric utilities in the localized distribution of electrical energy *to consumers*.

The cumulative results to date of the operation of the several systems of the Commission as set forth in this Report demonstrate a healthy financial condition.

The total investment of the Hydro-Electric Power Commission of Ontario in power undertakings and

TABLE No. 1

Distribution of Power to Systems
20-Minute-Peak Horsepower
system coincident peaks

System	October 1926	December 1926	October 1927	December 1927
Niagara system	800,000	809,651	810,322	853,960
Georgian Bay system	17,109	18,191	19,247	21,791
St. Lawrence system	6,790	6,932	8,246	9,033
Rideau system	3,076	3,150	3,290	3,123
Thunder Bay system	40,977	45,640	43,603	42,332
Ottawa system	16,354	17,728	18,480	18,794
Central Ontario & Trent system	41,166	43,901	43,458	47,994
Nipissing system	2,560	2,697	3,054	3,225
Total	928,032	947,890	949,700	1,000,252

hydro-electric railways is $204,372,-066.84, and the investment of the municipalities in distributing systems and other assets is $81,792,678.34, making in power and hydro-electric railway undertakings a total investment of $286,164,745.18. The total revenue derived from this capital investment aggregated $34,056,707.88 in 1927.

The following statement, Table No. 2, shows the capital invested in the respective systems and municipal undertakings:

TABLE No. 2

Niagara system	$157,273,132.98
Georgian Bay system	5,315,625.84
St. Lawrence system	1,328,384.25
Rideau system	1,173,928.46
Thunder Bay system	14,144,679.68
Ottawa system	143,441.05
Engineering—Power sites, Algoma district	7,288.23
Central Ontario and Trent system	14,260,456.10
Nipissing system	1,054,487.80
Hydro-electric railways	6,696,522.91
Office and service buildings, construction plant, inventories, etc., relating to all of the above properties	2,974,119.54
	$204,372,066.84
Municipalities' distributing systems and other assets (exclusive of $10,143,205.66 of municipal sinking fund equity in H.-E.P.C. system)—all systems	$81,792,678.34
	$286,164,745.18

The following statement, Table No. 3, shows the combined revenue of the Hydro-Electric Power Commission and the municipal electric utilities.

Revenue of Commission

As usual the Commission is able to report that the revenue obtained from the consumers has been more than sufficient to meet the full cost of generating and transmitting the electrical energy as well as to provide for all operating expenses and the fixed charges of the municipal utility equipments.

The Commission collected from the municipal utilities and other customers, for power sold, a total sum of $22,331,701.13. This sum was appropriated to meet all the necessary fixed charges and to provide for the expenses of operation and administration. After meeting all charges there was left a net surplus of $534,196.93

The following statement, Table No. 4, summarizes the Commission's collections from municipal electric utilities and other power customers for the year and shows how the collections have been appropriated.

Rural Electrification

During the past two or three years

TABLE No. 3

Revenue of the Hydro-Electric Power Commission :			
From the municipal electric utilities, rural power districts, Hydro-Electric railways and other power customers—			
Niagara system........	$16,684,817.42		
Georgian Bay system...	704,669.94		
St. Lawrence system....	253,526.04		
Rideau system.........	156,431.32		
Thunder Bay system....	1,030,395.10		
Ottawa system.........	190,653.30		
Bonnechere Storage.....	4,111.20	$19,024,604.32	
From rural consumers—			
Niagara rural power districts.....	$904,545.56		
" rural lines.....	5,258.63		
Georgian Bay rural power districts...	33,885.15		
" " rural lines.	274.72		
St. Lawrence rural power districts.............	18,852.11		
Ottawa rural power district................	16,107.47	$ 978,923.64	
From the Central Ontario and Trent System, also Nipissing System and the Pulp Mill .		2,328,173.17	
		$22,331,701.13	
From Hydro-Electric Railways—			
Sandwich, Windsor and Amherstburg Ry.....	$1,089,611.05		
Guelph Radial Railway.	115,794.95	1,205,406.00	
Total Revenue of the Commission........................			$23,537,107.13
Revenue collected by the municipal electric utilities........			24,583,022.13
Aggregate revenue of the Commission and the municipal electric utilities....................................			$48,120,129.26
*Deduct :			
Revenue from power supplied to :			
Municipal electric utilities.........		$13,975,890.69	
Hydro-Electric Railways.......... (See footnote)		87,530.69	14,063,421.38
Combined revenue.......................			$34,056,707.88

Note* This deduction is made due to the fact that the revenue of the municipal electric utilities is the source from which the Commission is reimbursed for the cost of power supplied to such utilities.

TABLE No. 4

Revenue from municipal electric utilities and other power customers		$22,331,701.13
Appropriated as follows :		
Operation, maintenance, administration, interest and other current expenses	$16,404,769.61	
Reserves for sinking fund, renewal of plant and equipment and contingencies.	5,392,734.59	
		21,797,504.20
Net surplus, after providing for all expenses and necessary fixed charges, credited to municipalities and shown in their accounts		$534,196.93

TABLE No. 5

RURAL POWER DISTRICTS—OPERATIONS FOR YEAR 1927

	Niagara system	Georgian Bay system	St. Lawrence system	Ottawa system	Central Ontario and Trent system and Nipissing system	Totals
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Cost of power as provided to be paid under sec. 23 of the Act	308,809.74	12,929.81	7,035.64	3,721.96	21,392.13	353,889.28
Cost of operation, maintenance and administration	235,553.62	7,102.90	4,464.42	6,738.88	15,098.82	268,958.64
Interest	92,675.93	5,124.98	2,617.49	2,649.55	4,949.46	108,017.41
Renewals	78,193.87	3,645.70	1,965.38	2,144.09	4,063.32	90,012.36
Contingencies and obsolence	39,096.93	1,813.86	982.69	1,073.05	2,088.30	45,053.83
Sinking fund	20,764.27	1,135.19	533.93	575.56	....	23,008.95
Total expenses	775,094.36	31,752.44	17,599.55	16,902.09	47,592.03	888,940.47
Revenue from customers	904,545.56	33,885.15	18,852.11	16,107.47	59,167.87	1,032,558.16
Surplus	129,451.20	2,132.71	1,252.56	....	11,575.84	144,412.31
Deficit	....	....	....	794.62	....	794.62
Net surplus	....	....	....	....	....	143,617.69

very substantial progress has been made in Ontario in the field of rural electrification. Practically all rural electrical service is now given through rural power districts which are operated directly by the Commission. There is now more than $5,200,000 invested in the rural power district system established by the Commission. Towards this rural work the Ontario Government, pursuant to its policy of promoting the basic industry of agriculture, has, in the form of grants-in-aid, contributed 50 per cent. of the costs of transmission lines and equipment, or about $2,600,000. About 2,850 miles of transmission lines have been constructed to date, of which 910 miles were constructed during the past year, a mileage which exceeds that constructed in any former year. There are now more than 25,000 customers supplied in the rural power districts.

Municipal Electric Utilities

The following is a summary of the year's operation of the electric utilities of the municipalities which operate under cost contracts with the Commission:

Reserves of Commission and Municipal Electric Utilities

The total reserves of the commission and the municipal electric utilities for sinking fund, renewals, contingencies and insurance purposes amount to $65,533,185.60, made up as in Table No. 7

The consolidated balance sheet of the municipal electric utilities, on page 229, shows a total cash balance of $3,014,832.48, and bonds and other investments of $1,696,237.66. The total surplus in the municipal books now amounts to $23,182,716.37, in addition to a depreciation reserve and sundry other reserves aggregating $11,322,805.74.

The Commission has been sensible of the necessity of building up its reserves in order to maintain this important public service on a sound financial basis. During the past seven years there have been placed in operation. Power properties—including that of the Toronto Power Company acquired by purchase—that have involved a capital outlay aggregating $136,000,000. As each of these properties came into actual operation supplying power to the systems of the Commission, the process of setting up reserves commenced. It may be pointed out that

TABLE No. 6

Total revenue collected by the municipal electric utilities....		$24,583,022.13
Cost of power...........................	$13,652,712.09	
Operation, maintenance and administration..	4,681,466.93	
Debenture charges and interest............	3,694,855.76	
Depreciation............................	1,262,000.65	
Total....................................		23,291,035.43
Surplus for the year, includes surplus from H.E.P.C..		$1,291,986.70

The above covers only the municipalities operating under cost contracts with the commission.

TABLE No. 7

Niagara system	$23,673,222.79
Georgian Bay system	1,379,191.18
St. Lawrence system	333,995.98
Rideau system	212,547.72
Thunder Bay system	612,547.82
Ottawa system	12,555.63
Central Ontario and Trent system	2,105,281.05
Nipissing system	145,692.83
Bonnechere storage	11,201.61
Service buildings and equipment	465,903.62
Hydro-electric railways	156,332.18
Insurance—Workmen's compensation and staff pension insurance	1,820,545.72
Total reserves of Commission	$30,929,018.13
Total reserves of municipal electric utilities	34,505,522.11
Total Commission and municipal reserves	$65,434,540.24

the reserves of the Commission during the past three years have more than doubled.

The following is a brief summary of the principal operations relating to the several systems of the Commission :

Niagara System

The Niagara system embraces all the territory lying between Niagara Falls, Hamilton, and Toronto on the east, and Windsor, Sarnia, and Goderich on the west, served with electrical energy generated at plants on the Niagara river.

There has been a steady increase in the number of consumers supplied on this system, and also in the loads supplied by the Commission to the municipalities. There are no large power developments under construction by the Commission at the present time to serve the Niagara system and the power supply available from the Niagara river will all be in use about the end of the year 1928. In order to provide for the immediate future demands for power, the Commission has entered into a long-term contract with the Gatineau Power Company for 260,000 horsepower. Delivery of the first block of this power is to be made about the end of the year 1928. This power will come from generating plants now being completed on the Gatineau river in the Province of Quebec, and will be received by the Commission at the inter-provincial boundary on the Ottawa river. It will be transmitted over a 220,000-volt steel-tower transmission line in the most direct route to Toronto where, at Leaside, the transmission line will be tied in to the Niagara system. The construction of this line is well under way and the receiving station will be started early in 1928. The power received from the Gatineau river will be 25-cycle power similar to the supply at present

given in the Niagara system of the Commission.

The Commission in this system has a total capital investment of $157,-273,132.98 and accumulated reserves for renewals, sinking fund and contingencies aggregate $23,673,222.79. In the rural power districts of this system, which are operated directly by the Commission, the revenue for the year from customers was $904,-545.56, and the total cost of supplying the service was $775,094.36, leaving a balance of $129,451.20, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates or cash.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power during the year was $416,246.54 less than the amounts of the interim bills. The municipal electric utilities operated with a net surplus of $940,-578.57 after providing $1,083,087.40 for depreciation and $1,375,901.26 for the retirement of instalment and sinking fund debentures. Seventeen municipalities had deficits during the year, aggregating $8,529.33. The total revenue of the municipal electric utilities in this system was $20,791,-106.65, an increase of $1,329,839.81.

Georgian Bay System

The Georgian Bay system serves that portion of the Province which surrounds the southern end of Georgian bay and lies to the north of territory served by the Niagara system and to the west of the territory served by the Central Ontario and Trent system. It extends from Kincardine on Lake Huron on the west to Uxbridge and Port Perry on the east, and as far north as Huntsville in the district of Muskoka.

This system obtains its electrical energy from five hydro-electric developments and one frequency changing station. The latter is situated at Mount Forest and is used to transfer power in either direction between the Niagara system and the Georgian Bay system as required. The total capacity of these plants approximates 22,000 horsepower. As the aggregate demand of the various municipalities comprising this system has reached the available capacity of the existing generating plants, and as the system peak load has been increasing at the rate of approximately 2,000 horsepower per annum for several years past, an investigation was made during the year covering provision for new developments, and arrangements have been made to undertake the construction next year of a new development of Trethewey Falls on the south branch of the Muskoka River a short distance above the Hanna Chute development which will provide an additional 2,300 horsepower in plant capacity. Arrangements were also made to undertake a further development of 12,000 horsepower for this system on the Musquash river which drains the Muskoka watershed. The construction of this development will be started next year and probably completed in about two years' time.

The past year was one of the most successful in the history of the Georgian Bay system, both with respect to the generation and transmission

departments controlled by this Commission, and the local distribution systems under the jurisdiction of the municipal commissions. The total capital invested by the Commission in this system is \$5,315,625.84, and the accumulated reserves, inclusive of renewals, sinking fund, and contingencies aggregate \$1,379,191.18. The revenue for the year from the rural power districts on this system which are directly operated by the Commission, amounted to \$33,885.15, whereas the total cost of service was \$31,752.44, thus leaving a balance of \$2,132.71 to be placed to the credit of the system, a substantial portion of which is returnable to individual consumers in the form of cash or reduced rates.

The results obtained during the year by the electric utilities in the various municipalities have been most satisfactory. The actual cost of power during the year was \$46,037.87, less than the total collections by means of interim bills. The total net surplus for the year from the various municipal electrical utilities amounted to \$85,980.24 after providing \$46,713.28 for depreciation, and \$47,508.23 for the retirement of instalment and sinking fund debentures. Seven small municipalities operated with losses aggregating \$4,087.47, whereas the total revenue of the combined municipal electrical utilities of the system was \$969,585.93.

St. Lawrence System

The St. Lawrence system serves the district immediately to the north of the St. Lawrence river between Brockville and Lancaster; the supply of power for the system being purchased from the Cedar Rapids Transmission Company, delivery being made at a point near Cornwall. Service is given to eleven municipalities, six rural power districts and two companies.

The Commission in this system has a total capital investment of \$1,328,384.25 and accumulated reserves for renewals, sinking fund and contingencies aggregate \$333,995.98. In the rural power districts of this system, which are operated directly by the Commission, the revenue for the year from customers was \$18,852.11, and the total cost of supplying the service was \$17,599.55, leaving a balance of \$1,252.56, which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates or cash.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power during the year was \$5,811.56 less than the amounts of the interim bills. The municipal electric utilities operated with a net surplus of \$37,806.15 after providing \$10,638.00 for depreciation and \$10,843.03 for the retirement of instalment and sinking fund debentures. One municipality in this system had a small deficit of \$205.28. The total revenue of the municipal electric utilities in this system was \$210,947.33.

Rideau System

The Rideau system serves the district in the vicinity of Smiths Falls, Perth and Carleton Place. Power is available from two generating plants, one at Carleton Place and the other installed by the Commission at High

Falls. Both are situated on the Mississippi river. The Commission also purchases power from the Rideau Power Company of Merrickville. The Carleton Place plant was in operation during the past year as a standby. The system supplies five municipalities situated between the Ottawa and St. Lawrence rivers, west of Ottawa.

The Commission in this system has a total capital investment of $1,173,-928.46 and accumulated reserves for renewals, sinking fund and contingencies aggregate $212,547.72.

With respect to the electric utilities of the municipalities comprising this system the actual cost of power during the year was $9,886.27 less than the amounts of the interim bills. The various municipal electric utilities operated with a surplus of $23,874.73 after providing $8,984.00 for depreciation and $13,212.09 for the retirement of debenture debt. There were no deficits. The total revenue of the municipal electric utilities in this system was $224,793.97.

Thunder Bay System

The Thunder Bay system serves the municipalities situated in the district of Thunder Bay at the head of the Great Lakes. Power supply for this system is obtained from the Commission's hydro-electric developments on the Nipigon River, about seventy miles east of Port Arthur. The Cameron Falls generating station is complete with an installation of 75,000 horsepower. Storage works at the outlet of Lake Nipigon regulate the outflow from the lake and the reservoir capacity is sufficient to provide for a complete regulation of the flow.

Apart from the demand for power for the ordinary domestic, commercial and municipal purposes of the cities served, the principal demand for power comes from terminal grain elevators and pulp and paper mills, the latter utilizing the greater portion of the generating plant output. During the past year, three of the ground wood pulp mills served by the system have been obliged to curtail production on account of adverse market conditions in that particular product. This has resulted in a lower power demand on the system than was anticipated. One of these mills operated at approximately one-third of its capacity during the year while the other two mills were closed down completely, one in July and the other in October. This condition is only temporary, however, as one mill ceased operation to complete the construction of a large extension to its plant, including the installation of a paper machine, and will resume operations again in July of next year fully equipped to manufacture newsprint paper, thus being assured of a local market for its ground wood pulp. The other mill, after closing down, was taken over by one of the strongest companies operating in Canada, and an additional contract has been executed with the Commission for 22,000 horsepower covering the supply of power for a new mill. Delivery of this power starts at the end of 1930. This mill will also be equipped to manufacture newsprint paper and thus, a recurrence of the adverse conditions experienced with these ground wood pulp mills is unlikely in the future.

The loss of load caused by these conditions has, however, been more than offset by the construction of a new pulp mill fully equipped to manufacture newsprint paper; and also by the construction of a large extension to an existing pulp and paper mill which has more than doubled its demand for power on the system. These additional loads, together with the power supplied for the first time to the city of Fort William during the year, have resulted in a substantial increase over the previous year in power sold from the system.

Due to the curtailment of the demands for power from the various pulp mills and to the fact that construction programmes for new mills and extensions to existing mills have been delayed, the construction work on the new Alexander development was temporarily closed down at the end of the year. It will be resumed again at an indefinite future date and so arranged that the new development will be ready to deliver power when required.

The city of Fort William was served for the first time at the beginning of the year, and has received service for nearly eleven months of the fiscal year. The highest twenty-minute demand established during the year was 8,660 horsepower, and the average for the year 7,194 horsepower.

The highest peak established by the city of Port Arthur during the year was 32,393 horsepower, being 4,176 horsepower greater than the highest peak established during the preceding year. The average load for the same period was also 1,988 horsepower greater than for 1926. A new pulp and paper mill was placed in operation at Port Arthur during the year, and the capacity of an existing pulp and paper mill was doubled during the same period. As these two additional loads were only served for a portion of the year the actual increase does not appear to be as great as it would have been had these loads been on the system for the full year. This accounts for the difference between the increase in the average load and the increase in the peak demand as compared with the previous year.

The 1927 annual financial statement for the Thunder Bay system, although showing a loss, proves the system to be in much better condition than in previous years and indicates improvement and progress, as the total average load sold, notwithstanding the reductions for the ground wood pulp mills, increased by 6,626 horsepower over 1926, with a corresponding increase in revenue. In addition, the system for the first time set up sinking fund reserve, this amounting to $130,022.16 for the full year. The other reserves set up for the year were, contingencies and obsolescence $60,626.05; being appromimately $36,000 greater than for 1926 and for renewals $107,267.29; or, approximately $8,000 greater than for 1926. Thus, the total reserves set up during 1927 exceeded those for 1926 by $174,765.42; whereas, the total deficit for the year was $64,042.-05.

The Commission, in the Thunder Bay system, has a total investment of $14,144,679.68, and accumulated

reserves for renewals, contingencies, and sinking fund aggregating $612,-547.82. The total revenue of the municipal electrical utilities in the system was $1,176,952.60, or $431,-000.05 greater than in 1926, and the total revenue collected by the Commission for power sold to the municipalities and private companies was $1,030,395.10; being $189,080.51 greater than for total collections from customers during 1926. The three municipalities served by this system operated with a net surplus of $89,-054.76 after providing depreciation to the extent of $23,970.00 and $23,-600.65 for the retirement of debenture debt, although one shows a net loss of $10,363.17.

Due to the construction of additional terminal grain elevators and extensions to those already in operation, to the resumption of operations next year by certain pulp mills, and to the new pulp mill load originating during the past year which will be supplied for the full term of the coming year, the prospects for the future on this system are most promising and studies and investigations already completed, based on accurate information, give indications of surpluses for next year and for several years to come.

Ottawa System

The Ottawa system comprises the city of Ottawa and the Nepean rural power district. It receives its power from a hydro-electric development on the Ottawa river adjacent to the city. Power for the Ottawa system is purchased through the Hydro-Electric Power Commission from a private corporation and, therefore, the municipalities of the Ottawa system are not acquiring any equities nor establishing reserves in power generating and transmission systems. It is interesting to note that, although Ottawa enjoys a very low average cost for electrical energy for domestic service, its net surplus after providing $56,410.00 for depreciation was $50,-116.64, an amount almost equal to the revenue received by the electrical utility of the city for the commercial power service it supplied. This is in addition to ret ring $19,410.13 debenture debt.

Central Ontario and Trent System

The Central Ontario and Trent system serves the district bordering the north shore of Lake Ontario, the westerly limit being the village of Pickering and the easterly, the municipality of Kingston. The nucleus of this system was a group of properties formerly controlled by the Electric Power Company, Limited, and operated by it through the agency of twenty-two subsidiary companies. These properties were all purchased by the province of Ontario on March 1, 1916, and have been operated by the Commission as trustee for the Province since June 1, 1916. Since that date the system has been greatly enlarged in order to meet the constantly growing needs of the district.

Twelve municipalities operating their own distribution systems under contract with the Commission, are grouped in what is known as the Trent system.

Fifteen municipalities where the Commission on behalf of the Province

operates the distribution systems and three municipalities receiving power under special conditions, are termed the Central Ontario system.

The power supply for the Central Ontario and Trent system, which is obtained from a number of power developments situated on the Trent and Otonabee rivers, has been somewhat taxed during 1927, owing to the sudden growth of load. Within the year the Commission has received requests for an additional 8,000 horsepower in one municipality alone and this, combined with the more than normal growth of load for the rest of the system, has created an unusual condition for the future. This is to be met by the construction of a new 44,000-volt line from Trenton to Oshawa and by the execution of a contract with the Gatineau Power Company for a future delivery of power.

For financial purposes, the Nipissing system referred to below, is included with the Central Ontario and Trent system. After operating, maintenance and interest charges were met out of the revenue from the system, the balance remaining was insufficient by the sum of $11,785.11 to meet in full the necessary amortization and depreciation reserves. The total reserves to date, provided out of earnings and held specifically for the benefit of the system, amount to $2,250,973.88.

Nipissing System

This system serves the district adjacent to and inclusive of the city of North Bay, the town of Powassan and the villages of Callander and Nipissing. The plant and properties comprising this system form a part of those acquired by the Province in 1916 from the Electric Power Company, Limited, and have been operated by the Commission since that date in a manner similar to that employed in the case of the properties in the Central Ontario district. Two hydro-electric developments serve the Nipissing system, both being situated on the South river, one at Nipissing and the other at Bingham Chute.

Investigations were carried on during the year respecting the provision of additional hydro-electric development which will soon be required. There has been a steady increase in the demand for electrical energy especially in the city of North Bay, and it is anticipated that the entire available capacity of the two existing developments will be required to supply the demand during the coming year. Plans are being prepared to begin the construction of the new development during the next twelve months so as to provide for meeting the increase in load before the municipalities are confronted with the seriousness of a power shortage.

Due to the expiration of the franchise in North Bay, under which service has been given in the past to that municipality, negotiations have been carried on with the city council covering future operations, and such progress has been made that it is expected that in all of the municipalities on the system by-laws will be submitted to the ratepayers during the coming year respecting the purchase of the local distribution system,

thus permitting operation in accordance with the standard practice under the Power Commission Act.

The Annual Report

The Table of Contents, pages xxi and xxii, conveys a good understanding of the scope of the matters dealt with in the Report, to which there is also a comprehensive Index. To those not conversant with the Commission's Reports the following notes will be useful.

In Section II, pages 7 to 48, dealing with the Operation of the Systems, are a number of interesting diagrams showing, graphically, the increase in the loads on the various systems. Tables are also presented showing the amounts of power taken by the various municipalities during the past three years.

The rural distribution work of the Commission has proved of widespread interest and special reference to this is made in Section III, on pages 56 to 66. The power distributed to rural districts is, and probably must always be, but a relatively small proportion of the power distributed by the Commission. The supplying of electrical service in rural areas, and especially on the farm, has, however, been of great economic benefit to Ontario. The Provincial government grants-in-aid to this work have been of assistance to agricultural activities, and have enabled the Commission to extend transmission lines to many areas which could not otherwise have received the benefits of electrical service.

In Sections IV, V and VI will be found information respecting progress of work on new power developments and on transmission system extensions, together with photographic illustrations.

About three-fifths of the Report is devoted to statistical, financial data which are presented in two Sections, IX and X.

Section IX presents in summary form the financial statements relating to the operations of the Commission in the generation, transformation and transmission of electrical energy to the co-operating municipalities. It is introduced by an important explanatory statement which appears on pages 108 to 113, to which special reference should be made.

Section X presents in summary form the financial statements relating to the operations of the municipalities in the localized distribution of electrical energy to consumers. It also contains details of the costs of electrical energy to consumers in the various municipalities and tabular statements of the rates in force which have produced these costs. An explanation of the various tables and statements is given at the commencement of this Section on pages 223 to 225; and a special introduction to Statement "D," which relates to the cost of electrical service in Ontario, together with a diagram, appears on pages 327 to 329.

In its Annual Reports the Commission aims to present a comprehensive statement respecting the activities of the whole undertaking under its administration. Explanatory statements descriptive of the operations of the Commission in various branches of its work are suitably

placed throughout the Report in order that the citizens of the Province may be kept fully informed upon the working-out of the Commission's policies.

To-day the Commission is distributing about one million horsepower, and the "Hydro" organization has become firmly established in the general social, commercial and industrial structure of the Province. Recognizing the needs for the future, the Commission is employing every means within its power to provide for the further development, in the most economic manner, of the undeveloped provincial water-power sites, so that hydro-electrical energy may be available at a minimum cost as and when required to meet the needs of the public. This policy of public-ownership and development does not preclude the Commission from occasionally purchasing electrical power when it finds it is good business to do so, and such special purchases of power are in no way to be regarded as a departure from the general policy of the Province with respect to its hydro-electric resources.

The Commission has devoted special attention to facilitating the building-up of suitable reserves in order that the property of the municipally-owned undertaking may be fully safe-guarded, as well as maintained in a highly-efficient condition. It is believed that the efforts along these lines have met with the special approval of the interested municipalities.

It is again my privilege on behalf of the Commission to express its appreciation to the Press of the Province for its service to this great undertaking. Also, the Commission is deeply sensible of the loyal co-operation of its staff, and of the good-will and support of the members of all the local organizations connected with this extensive public work.

Respectfully submitted,

CHARLES A. MAGRATH,
Chairman

HIGHLIGHTS FROM THE MUNICIPAL SECTION OF THE 1927 ANNUAL REPORT

		1927	Increase over 1926
Total	Municipal plant cost	$65,522,255.85	$4,905,634.90
"	Bank and cash	3,014,832.48	878,541.69
"	Securities and investments	1,696,237.66	295,921.23
"	Assets	91,935,884.00	9,196,474.78
"	Liabilities	47,287,156.23	3,314,417.36
"	Reserves for depreciation, etc.	11,322,805.74	1,014,513.24
"	Reserves for Sinking Fund	6,398,909.77	799,234.76
"	Debentures paid off	6,648,767.38	1,154,887.55
"	Equity in H.-E.P.C	10,143,205.66	2,096,337.13
"	Surplus accumulated	10,233,684.58	915,730.10
"	Operating surplus for 1927	1,291,986.70	114,798.25

During the year cash refunds were made to individuals and municipalities aggregating approximately $365,000.00, which of course reduced the accumulated surplus by that amount.

Of the 252 municipalities whose operation is included in the report, only 12 had gross deficits aggregating \$6,305.12, while the net surplus for all was \$1,291,986.70, after providing \$1,521,510.30 for the retirement of debentures, and \$1,262,000.65 for depreciation.

Application of Hydro-Electric Power to Farm Work

Article No. 14

WHEN the extension was made north of Woodbridge in 1924, service was connected to the farm of Mr. Henry Ellis,which is located north of Kleinburg. The importance of the service in the house and other farm buildings is about balanced, and advantageous application is being made with a view to the saving of labour and effort in both the home and the barn. The installation consists of :

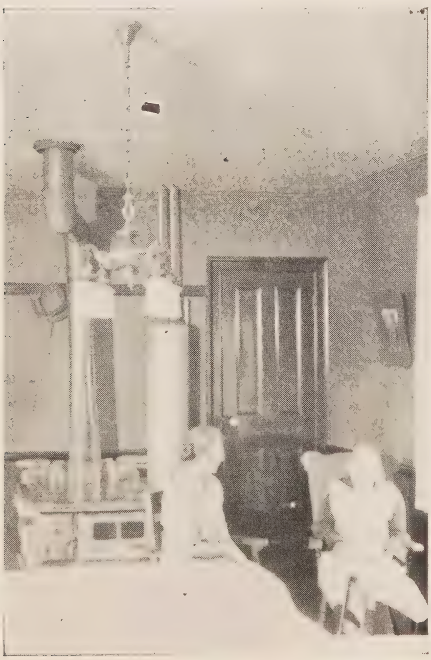
Lighting in house, 30 on 13 switches	1,200	watts
Lighting in barn and other buildings, 14 on 6 switches	560	"
Lighting in yard	100	"
Total Lighting	1,860	"
Iron	600	"
Washing machine	186	"
Automatic water system	186	"
1 h.p. motor on deep well for barn uses	746	"
3 h.p. motor on chopper	2,238	"
$\frac{1}{4}$ h.p. motor on direct belted cream separator	186	
Total connected load	6,002	"

The arrangement of location of buildings on this farm is very convenient for operation of the place and for distribution of the electric services.

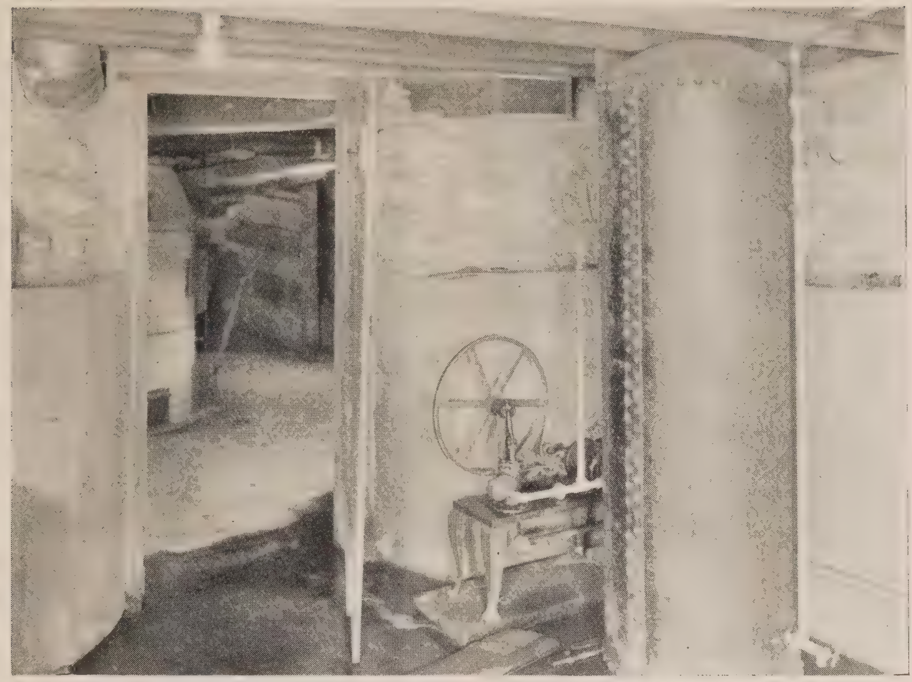
The net cost and consumption for the twenty-five months' period are submitted below. The service supplied is Class 3.

	To May 31, 1927	From May 31, 1927, To April 30. 1928
Service charge.	$3.85	$3.85
Consumption for first 42 kw-hr. per month	5 cents	4 cents
Balance of uses per month.	2 cents	2 cents
Prompt payment discount.	10%	10%

Months.	Ending	Consumption Total	Consumption At 2nd Rate	Net Bill	First Kw. Rate
	1926				
3	June 30	84		$14.18	5 cents
4	Oct. 31	173	5	21.51	5 "
	1927				
3	Jan. 31	221	95	17.78	5 "
4	May 31	267	99	23.20	5 "
3	Aug. 31	129	3	14.99	4 "
3	Nov. 30	253	127	17.22	4 "
	1928				
2	Jan. 31	267	183	13.25	4 "
3	April 30	178	52	15.87	4 "



The living room and winter kitchen. The automatic water system under pressure makes it possible to have hot water by using a coil in the furnace or a water front in the kitchen stove.



An automatic water system provides a soft water supply for bathroom and kitchen, including hot water. This one has a storage tank. The range of pressure is from 20 to 40 lbs.

The average consumption and costs are :

Consumption per month 62.9 kw-hrs.

Cost per month, including service charge . . . $5.52

Cost per kw-hr., including service charge . . . 8.8. cents.

Mr. Ellis gives the following uses as made with the Hydro service on this place. Those in the house consist of the ordinary requirements for a family of six, *i.e.*, for water service, including that for a bath room, the washing machine for a family of this size, and the electric iron. In the barn, besides lighting, power is used for the following :

Chopping 400 hundredweight of chop per year.

Separating cream from the milk of 11 cows; this service taking 20 minutes each time every morning and night every day in the year.

Pumping water from a deep well for 30 head of cattle, 6 horses and 25 pigs.

As a possibility for the future it is proposed to include a half-horsepower portable motor for driving a fanning mill, emery stone, etc. This is considered a better form of application of power instead of having a line shafting driven by his 3-horsepower motor now installed.

The washing machine, electric iron, table grill or toaster, and the service entrance in the summer kitchen.

It is to be noted that the total net cost per annum is $66.24.

Mr. Ellis is very enthusiastic in his expressions with reference to the great saving of labor effected by the application of his Hydro power to the work partially itemized, both in the house and in the barn.

The applications on this farm are considerably greater than those on the S. A. Davis place, which was written up in our Article No. 1. For purpose of comparison, we are submitting the records of this farm where the service, while quite satisfactory to the owner, is not applied to as many kinds of work nor as much work.

The cream separator with a ¼ horse-power motor, direct belted to the machine, a belt tightener with spring control provides for the necessary slip to allow time for the separating element to come to speed. On most forms this part of the electric service is considered a boon by the person who formerly had to man the crank. The amount of power used per month on most farms is less than 5kw-hr.

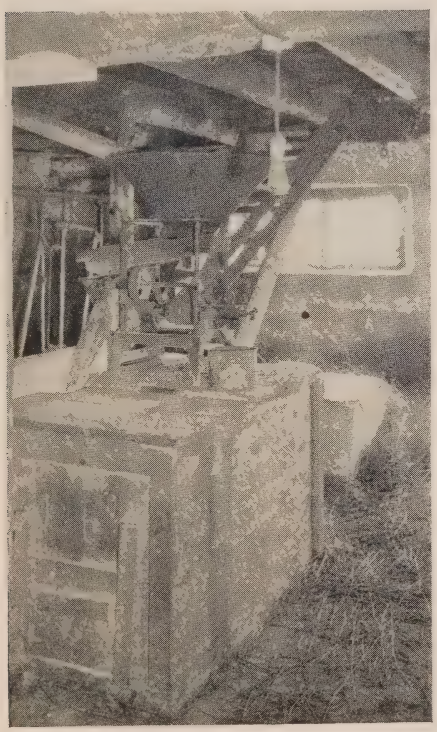
Months	Ending	Consumption Total	Consumption At 2nd Rate	Net Bill	First Kw. Rate
	1926				
3	June 30	52		$12.74	5 cents
4	Oct. 31	134		19.89	5 "
	1927				
3	Jan. 31	151	25	16.52	5 "
4	May 31	239	71	22.70	5 "
3	Aug. 31			10.40	4 "
3	Nov. 30	81		13.31	4 "
	1928				
2	Jan. 31	115	31	10.51	4 "
3	April 30	105		14.18	4 "

The average consumption and costs are :

Consumption per month about.............................31.4 kw-hrs.

Cost per month, including service charge..................$4.81

Cost per kw-hr., including service charge..................13.7 cents.



The 6¼-inch plate chopper, driven by a 3-horsepower motor mounted on the ceiling. The supply to the chopper is from a bin above, through the spout shown on the left of the hopper, the chop being delivered to the box on which the chopper is mounted. The hay on the right had just been put down. The tank back of the chop bin is an expansion tank connected to a watering trough on the outside to prevent breakage in case of ice forming in the trough.

Totalizing and Remote Metering Methods

By H. S. Baker, Meter Supervisor, H.E.P.C. of Ont.

(Continued from May Number)

Fig. 16. Shows *The Potentiometer Method* of remote metering and totalizing. This system is capable of a high degree of accuracy (for remote metering) but requires an accurately regulated supply of a small d.c. amperage at both transmitting and receiving ends. The supply of d.c. amperage can be taken from a couple of dry cells in parallel as only about 10 milliamperes at a fraction of a volt is required. The amperage can be automatically regulated to agree continuously with a standard cell and resistance, by using standard Leeds and Northup recorders, or it can be set to standard value daily by means of a slide resistance and indicating ammeter. The batteries in one particular instance ran down roughly one percent in 4 or 5 days and required renewing every 5 months, no increase of current was ever noted as might be occasionally expected if the battery current were affected by varying temperature.

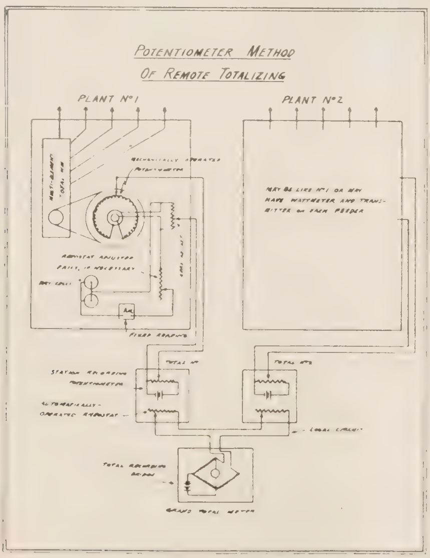


Fig. 16

If three wires are used between transmitter and receiver, then a bridge circuit can be used and requires only the one source of power which can be at either end. In this case, quite wide variations in the supply voltage do not affect the accuracy of the receiver. It is assumed that temperature effects upon two of the conductors will be alike and balance out.

The source of mechanical power for operating the transmitting potentiometer can be from a multi-element totalizing wattmeter, or if a number of transmitters are used, then each can be operated from its own single element wattmeter. The delivered d.c. voltages from the transmitters can be summed up to feed one receiver.

It may be desirable to have in the load dispatchers office a separate totalizing receiver for each Generating Station, and then by means of a local bridge circuit have a grand total meter fed from transmitters in the various sub-total meters.

The Leeds and Northup recorder used as a graphic millivolt-meter may have a full scale voltage of almost any desired value, say from 8 millivolts d.c., to any higher value.

The instrument contains a slide resistance potentiometer from which a voltage is picked off depending upon the position of the sliding contact, or the pen of the instrument, which are connected together. This voltage is bucked against the incoming voltage to be measured and the difference applied to a sensitive D'Arsonval galvanometer.

If the position of the sliding contact and pen do not produce the correct counter e.m.f., to balance out the incoming voltage then a slight current will flow through the galvanometer and deflect its pointer. The deflected pointer is grasped by a pair of continually oscillating arms and the obstruction to the motion of the arms causes a friction clutch to move the sliding contact and pen toward the point of accurate balance, when the galvanometer will return to zero current position and the incoming voltage circuit will be delivering zero current to the recorder. This instrument might be called a mechanical relay type of instrument as it contains no make and break contacts but does act as a relay in which the motion of the galvanometer pointer controls the application of mechanical power from a continuously running motor to a pen mechanism.

Fig. 17. Shows the *Current Method of Remote Totalizing.*

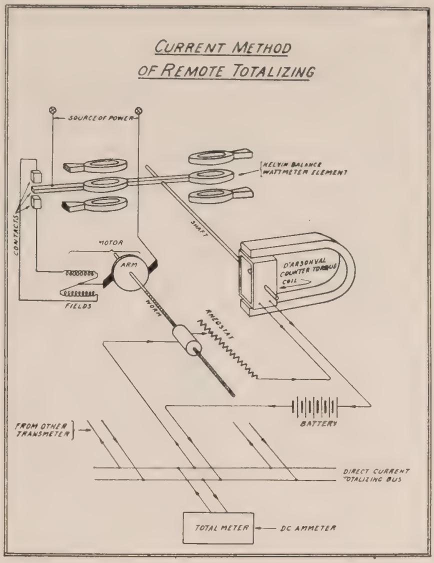


Fig. 17

A Kelvin balance type of wattmeter element is used to produce a torque proportional to the power to be measured. This can, if desired, be a multi-element meter. This torque is balanced out by the negative torque of a D'Arsonval type of meter element whose current is automatically regulated to produce balance. The momentary difference between these two torques (before balance is obtained) closes one or other of a pair of contacts which in turn operate a motor forwards or backwards that varies a rheostat and adjusts the D'Arsonval current towards the correct value to produce balance.

As the D'Arsonval current is proportional to its torque which balances the load torque, this current is also proportional to the load to be measured, and can be transmitted long distances to the receiving instrument.

The sum of several such currents can be fed through one receiving instrument which can be a D'Arsonval

type of ammeter, either indicating or graphic.

An ampere-hour meter in series with the receiver will register total kw.-hr.

Separate receiving meters can be used at the receiving end with each transmitted circuit if desired without complicating the totalizing arrangement.

The source of d.c. supply to feed the transmitter does not require to have a constant voltage as the automatic balance arrangement will take care of variations of supply voltage as well as of variations in load to be measured. A source of direct current with wide and sudden variations should however, be avoided.

The Writer has not had personal touch with the practical working out of this and the following schemes and it is hoped that those in closer touch will fill in such data as have been omitted, during the discussion period.

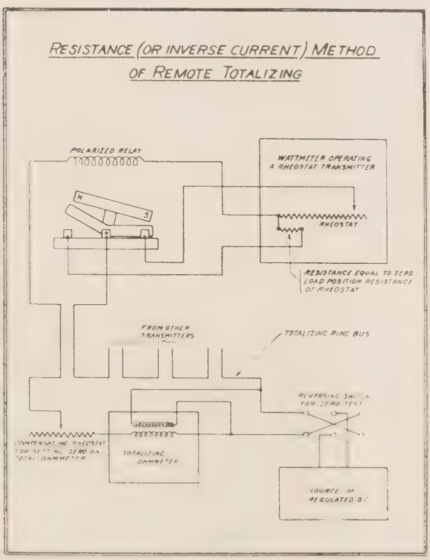


Fig. 18

Fig. 18. Shows the *Resistance or Inverse Current* method of remote totalizing.

The transmitter consists of a wattmeter which operates a rheostat and cuts in resistance in proportion to the feeder load to be measured. Zero load is not necessarily zero resistance as it is desirable that a slight negative indication be obtainable for proper checking of zero as approached from above and from below. It may also be necessary to transmit negative values of load when reversal of power in that particular feeder occurs.

Each transmitter will have a definite position of sliding contact representing zero power.

Consider all transmitters on zero position connected in series by means of the copper conducting wires from transmitters to receiver. There will be a considerable copper resistance of connecting wires in series with the total resistance to be measured, and hence the resistance of the transmitters should be made high enough so that the temperature variation of the copper resistance is a small fraction of the total.

The reading of the totalizing ohmmeter with all transmitters on zero position will, of course, indicate zero total power.

A sliding contact resistance is shown to compensate for temperature changes in copper resistance. This adjustment is periodically performed as follows;—

The polarity of the main d.c. supply is reversed by means of a reversing switch. Polarized relays at each transmitter then cut out the transmitters and cut in blocks of resistance

corresponding to zero position of transmitter. If the total ohmmeter does not now show correct deflection for zero total load, then the compensating rheostat is varied till it does. The polarity of the d.c. supply is then put back to normal and the transmitters are automatically cut in service again.

If the source of d.c., is accurately regulated as to voltage, then the ohmmeter does not require a potential coil, and an ammeter calibrated in ohms can be used.

On account of the high value of the total resistance it has been found in one case desirable to use a rather high value (1200 volts) of d.c. supply from a generator using a Tirrill regulator. This system was of the order of 200 miles in extent, using No. 8 copper conductor.

Fig. 19. Shows the *Impulse Method* of remote totalizing.

The transmitter consists of a make and break commutator on the shaft of a watthour meter. The resulting impulses operate a relay at the receiving end which in turn operates a reversing relay that simply turns a condenser end for end and then back again at each impulse. The two reversals of the condenser allow two condenser charges to be discharged through a receiving d.c. ammeter (either graphic or indicating).

The value of these condenser charges depend on the supply voltage which should be of a fixed value.

The load to be transmitted produces in the transmitting watthour meter a number of impulses per minute proportional to the load. The number of condenser discharges per

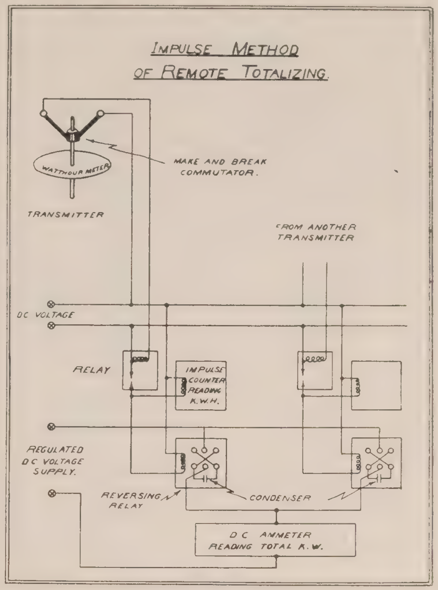


Fig. 19

minute through the receiving ammeter is a measure of the average d.c. flow through this meter and hence a measure of its indication, which represents transmitted reading.

The figure shows two transmitters feeding into one receiver. Should one condenser discharge into the receiver and into the second condenser just before the instant that the second condenser was disconnected from the receiver, then some charge would fail to flow through the receiver that should have done so. The writer is not aware if this consideration represents a practical error but if so, then resistances between each condenser and the receiver would minimize the back feed mentioned.

An impulse counter is shown for each transmitter which registers kw-hr., for that transmitter.

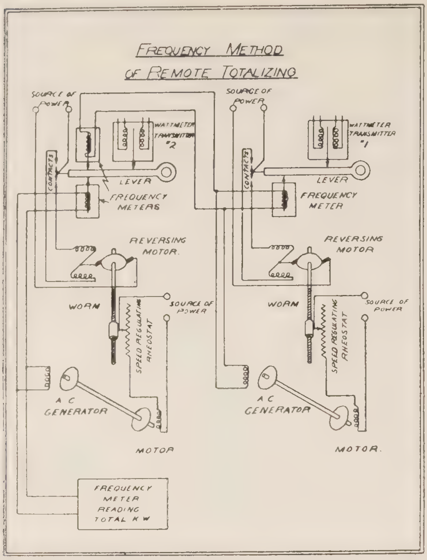


Fig. 20

The writer is not aware as to the practical working out of the effect of commutator friction upon the accuracy of the transmitting watthour meter, or variation of this friction with time.

Fig. 20. Shows the *Frequency Method* of remote totalizing.

Wattmeter No. 1 measures the first block of power to be remotely totalized. The mechanical force from this wattmeter element bears down on the lever shown. This force is balanced by the opposite force of the frequency meter element acting on the same lever. Both the wattmeter and the frequency meter should have straight line relations between measured quantity and torque. Should the frequency arriving at the frequency meter be lower than the value necessary to balance the torque from the wattmeter, then the lower contact will be closed and the reversing motor will run in a direction to raise the frequency delivered by the a.c. generator to the frequency meter. When balance occurs and the reversing motor stops, then the frequency is at a value representing the amount of watts received by the wattmeter.

This frequency is transmitted to the location of transmitter No. 2 and energizes a frequency meter there.

The torque from this second frequency meter plus the torque from transmitting wattmeter No. 2 both bear down on the lever of transmitter No. 2. Opposed to the sum of these two torques is the torque of a third frequency meter and if balance does not obtain, then the lever contacts operate the second reversing motor and regulate the second frequency till this torque balances the value of the first frequency plus the second wattmeter.

When balance is established, then the second frequency measures the total watts of No. 1 and No. 2 transmitters, and a receiving frequency meter then registers total kw. load. This system appears to contain a large number of moving parts and if the frequency elements (translating frequency into torque) are of the whirling magnet and aluminum cup type, driven by synchronous motor, then there would appear to be an error due to varying temperature of this element.

Fig. 21. Shows the *Selsyn Method* of remote totalizing.

Transmitter No. 1 consists of a Selsyn motor or induction regulator having three phase wound rotor and three phase stator. The mechanical

position of the rotor is determined by the deflection of the wattmeter on No. 1 block of power.

This position in turn determines the phase position of the voltage triangle delivered by the rotor of No. 1 transmitter to the stator of No. 2 transmitter.

The mechanical position of No. 2 transmitter is fixed by the wattmeter on No. 2 block of power. This mechanical position in turn determines the difference in phase positions of the triangles received by, and delivered by No. 2 transmitter. The final triangle received by the receiver then is advanced ahead of the supply triangle by the sum of two time angles representing the two component loads.

This receiver measures the advance of its rotor triangle ahead of the supply voltage triangle which is total kw. load.

The writer is not aware of the accuracy of this method or of the

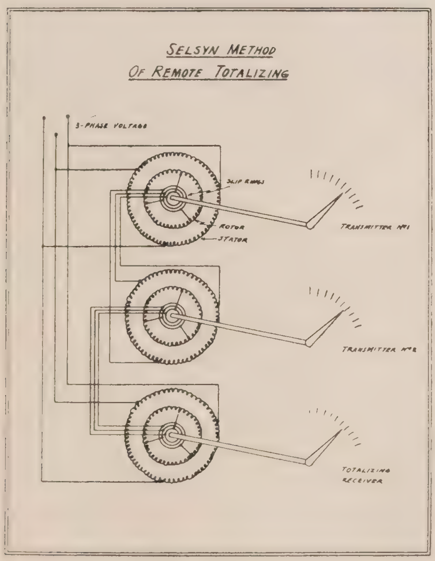


Fig 21

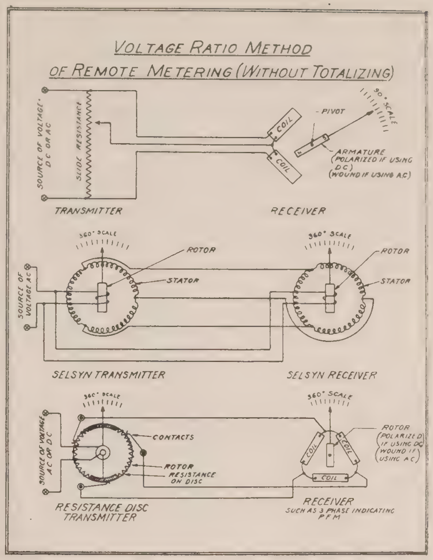


Fig. 22

effect of phase displacement between sending end and receiving end of one connecting transmission.

Fig. 22. Shows the *Voltage Ratio* method of remote indication without totalizing which has for the receiving instrument two or more stationary coils mounted at different angles and acting upon a moving armature which is in balance and free to rotate without deflecting a spring. The relative strengths of the current in the coils determine the position of the free armature.

The transmitter may be induction type as a Selsyn motor or may be a slide resistance with voltages picked off from the slider to either end. A form of this device used to give 360 degree angle of transmitted motion may consist of two Selsyn motors as transmitter and receiver or may have a circular resistance disc as transmitter and Westinghouse indicating power factor meter as receiver. The

transmitting disc has two conducting segments occupying 60 degrees each and on opposite ends of one diameter. These are connected to the source of power through slip rings. The remaining two spaces on the disc are occupied by resistance windings. Three brushes at 120 degrees apart play on the circumference of this disc and feed the three coils of the receiver. The maximum theoretical error from correct reproduction of the transmitted angle is 1.2 mechanical degrees. This device is suitable for transmitting position of field rheostat finger, or turbine gates or water level.

Power System Comparisons

IN its issue of May 5, 1928, the *Electrical World* gives statistics covering the larger electric systems on the North American continent for the year 1927. These are limited to only those having an output of over 100,000,000 kw-hrs. Of such systems there are shown to be 124 in the United States, fifteen in Canada and two in Mexico. In addition fourteen railway systems fall by virtue of their size into the same classification.

On the basis of kilowatt-hour generated and capacity of hydro-electric generating equipment, the Hydro-Electric Power Commission of Ontario has first place for the continent.

The 124 systems in the United States operated 1,423 plants, with a total rating of 24,275,311 kv-a., divided into 17,255,891 kv-a. in fuel burning plants, and 7,019,420 kv-a. in hydro-electric. In Canada the 15 systems operated 68 plants with a total rating of 2,791,034 kv-a. 79,750 kv-a. being in fuel burning plants and 2,791,034 kv-a. in hydro-electric.

The largest generator capacity on the continent is that of the Commonwealth Edison Company, being 1,004,500 kw., all of which is in fuel burning plants. The next is the Edison-United and Allied Companies with 972,225 kw., which is also in fuel burning plants. Duke Power Company is shown as third with 244,313 kv-a. in fuel burning plants, and 658,082 kv-a. in hydro-electric. Next in order is the Hydro-Electric Power Commission of Ontario with 799,854 kv-a., all of which is in hydro-electric plants and showing it to have the greatest capacity of hydro-electric plants for any system on the continent. Taken on the basis of system peak load, estimated over a thirty-minute period, Commonwealth Edison Company comes first with 916,000 kw. Next is Edison United and Allied Companies with 765,703 kw., while the Hydro-Electric Power Commission is third, having 740,530 kw. actual load over a twenty-minute period.

The system showing the largest output for the year was the Buffalo, Niagara & Eastern Power Corporation, which had 4,634,341,084 kw-hr., of which 3,642,781,815 kw-hr. were generated and 991,559,269 kw-hr. were purchased. This included the output of the Canadian Niagara Power Company, Limited, which was 604,597,700 kw-hr., all being generated. The second largest output was that of the Hydro-Electric Power

Commission of Ontario, being 4,133,501,842 kw-hr., of which 3,929,373,496 kw-hr. were generated and 204,128,346 kw-hr. purchased, showing the Commission to be in first place according to the amount of power generated.

It will be noticed from the above that this system is in the 1,000,000,000 kw-hr. class, of which there are 21 systems and one electric railway in the United States, and four systems in Canada. Other Canadian systems falling in this class in order are Shawinigan Water and Power Company, Duke Price Power Company Limited and Montreal Light, Heat and Power Consolidated. Compared with similar reports for previous years, it is shown that there is a steady growth in the output of the individual systems. For the year 1923 there were only five Canadian systems reported with over 100,000,000 kw-hr. output. In addition to 10 other systems having since qualified for this classification, the output of the five original systems has increased by more than 50 per cent., while the system peaks have increased in a slightly less proportion.

Electricity in Favor Among Poultry Raisers

Interesting and profitable results have been obtained by poultrymen in Oregon and other western states through application of electricity. Ease of regulation, reduced labor, less crowding and great cleanliness are some of the advantages claimed. The cost of power for lights and of extra feed consumed is relatively small compared with the increased returns. Experiments conducted under the direction of the Oregon state agriculture college have proved that electric brooders are satisfactory if operated properly, and that electric lights in yards and feed rooms and for testing eggs are very desirable, and when power is used also for other purposes the cost is low.

Electric power was used successfully on a farm at Lebanon, Oregon, where a home-made oats sprouter, a root shredder and a kale cutter were operated. Sixty pounds of carrots were shredded by one man in three minutes at a cost of three-tenths of a cent for power. On this same farm the power cost per 100 eggs was 31½ cents on 512 egg-electric incubators, while on another farm the power cost per 100 eggs was 6½ cents on 13,000-egg electric incubators. On still another farm electricity was used on a 1,000-chick size brooder at a cost of 2.6 cents per chick, the loss being 10 per cent. on 350 chicks.—

Transactions, I.E.S.

Correction

We are advised that the note in the the May *Bulletin*, Page 167, in reference to the marriage of Mr. V. S. McIntyre, Kitchener, contains some errors, which we put down to our difficulty in obtaining the data. Mr. McIntyre says that we got the name wrong, the date wrong and that they did not stop in Hamilton. We are pleased that with the exception of these minor details the information given is correct.

HYDRO NEWS ITEMS

Central Ontario System

Estimates have been prepared for the supply of power to two large mines in the vicinity of Madoc.

* * * *

The Central Spring and Axle Company located in the City of Oshawa is making a contract with this Commission for a supply of 400 h.p. to operate a resistance type annealing furnace.

* * * *

The Cobourg Rural District is extending rapidly. Ten miles of line are now under construction and contracts have been received covering 13.5 miles of line to serve Gores Landing, Harwood, and the territory between Cobourg and Rice Lake.

* * * *

Niagara System

A request has been received for 500 h.p. to operate a quarry at Innerkip. The product of this quarry is crushed rock, being used for ballasting the Canadian Pacific Railway.

* * * *

Rural offices have been established in Aylmer and Tillsonburg, and the billing of the rural consumers in the adjacent rural power districts will be done from these offices.

* * * *

An extension of 6.3 miles of line has been built from the Galt-Hespeler Highway to supply consumers at Puslinch Lake and en route in the Preston Rural Power District, service being made available about the middle of this month.

* * * *

Arrangements are being made to construct a section of 26 kv. line and a distributing station in the town of La Salle to supply the town and part of Sandwich Rural Power District. It is expected that the installation will be completed in time for the load of next winter.

* * * *

The demand of the rural power consumers in the vicinity of Rondeau Provincial Park, Kent County, has increased to such an extent that it has become necessary to erect a 26 kv. line and a distributing station to serve them. The installation was completed and power turned on early in this month.

* * * *

Six miles of rural power line is being built to supply Pt. Pelee, the most southerly point in Canada. The line will supply farms and summer cottages, and it is expected that Hydro power will be used to supplement the large drainage pumps now operated by steam power. Large tracts of land are drained so as to make it suitable for agriculture, and are mostly used for intensive onion growing.

* * * *

A request has been received for service to the old Colonel Talbot

estate, in the St. Thomas Rural Power District, which is now owned by a man in Detroit. The estate comprises some 700 acres of land and was sold on condition that all the furniture would be retained and British traditions upheld. This estate is one of the most beautiful spots in Ontario, as well as being rich in historical events, covering the early period in Ontario development. A great deal of the furniture in the house was used by the Colonel, and consists of pieces that are now ranked as gems of early Canadian handicraft.

Lightning Destroys Radio

A report comes from Chesterville of the destruction of a radio set during an electrical storm on Saturday, May 19th. During a heavy storm which passed over that district the aerial of a valuable receiving set, owned by Mr. Charles Kearns, is supposed to have been struck by lightning. The machine was practically blown to pieces, accompanied by a loud report. The lightning came in on the lead-in wire, jumped to a house lighting circuit, from which it passed to ground, which probably prevented the occurrence of fire. As for the aerial, none of it could be found, having been completely consumed during the discharge.

Electric Sun Makes Contented Cows and Hens

Cows love to stand in their stanchions on cold winter days and bask in violet rays from an electrical apparatus over them. Hens rush into the room where the rays are disseminated, ruffling up their feathers as though they were locating a nice, soft pile of dry dust.

The United States Department of Agriculture has taken notice of these facts and Dr. E. W. Allen, chief of the Department's experimental stations, says that not only do cows and hens like it, but that the treatment makes the quality of the milk and eggs much better and that babies fed such milk are practically immune to rickets. The violet ray method of improving farm output is approved by the government and is being adopted on more farms each year.

Dr. Allen says, "Nobody knows why a little sunshine or its substitute, an electric ray, playing over the backs of cows and hens results in better milk and more fertile eggs—but it is so."—*Transactions, I.E.S.*

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Everything Has to Be Sold

By W. H. Griffin, Advertising Manager, Southam Press, Limited, Toronto

(Address to Association of Municipal Electrical Utilities at Niagara Falls. Ont. June 14, 1928.)

FOLKS, I am just an ordinary printer. When I arrived at the ripe old age of eleven years, I traded my bicycle for a little printing outfit and started out to make my million. I might say here and now that, up to the present time, I have not succeeded, but I have had a lot of fun. I have been privileged to listen to the intimate business problems of institutions ranging from the smallest, up to those of considerable size, and there are one or two things that I have been privileged to learn. One is that the greatest asset of any business institution, big or little, is not its stock of goods, is not the building in which it operates, but its customers; and the other one is that everything, from raisins to religion, has to be sold. Down through the ages, every man has owed his success to his ability to sell his product, his services, or his ideals. The preacher in the pulpit has to be one of two things—a salesman or a failure. Every married man here, at some time, sold some little woman with the idea that he was the right man for her; and God knows most of us have misrepresented the goods ! And when we got her sold, I will leave it to everyone of you if we do not have to keep her sold. What did we buy her that new electric range for ? We, of course, told her that it was to make her work easier, and all that stuff, but we did it to cut down the fuel bill. Folks, one night not very long ago, I happened to be

CONTENTS

Vol. XV **No. 7**

July, 1928

	Page
Everything Has to Be Sold	217
Development in Line Construction	221
Modern Street Lighting	235
A.M.E.U. Notes	242
Electrical Inspection Under the Commission in Ontario	245
Sources of Power	249

home and was called to the door. The young man who stood there told me he was representing a certain insurance company. He said he had an interesting story to tell me. I said, "Well, if you have an interesting story to tell, and have time to tell it, I surely have the time to listen. Come on in." He told his story, and he told it well. When he had finished I complimented him on the convincing and orderly manner in which he had told this story, and I asked him where he got it. He said it was all printed in the sales manual of the institution he represented. He went away. In a few moments, another caller arrived. This man told me he was the pastor of the little church just down the street. I said, "Well, now, just a moment, brother. An insurance man just left here and told me I was going to die. Is it possible that you are here for the job of preaching the funeral sermon?" He said "No"; that he had an interesting story to tell me—just the same as the other fellow had introduced himself. I said, "All right; come on in." He said, "Mr. Griffin, I would like you to become a member of our little congregation." He apparently was not interested particularly—at least he didn't say that he was—in my salvation. He wanted to get me to become a member of his congregation, so he said. I might say that he might have been looking for the horrible example—I don't know. Anyway, he completed his story. The point is this: Fundamentally, there was no difference between his sales talk and the sales talk of the insurance man. He went away. I sat there and thought. I could not help it. I thought of how everything, in the last analysis, has to be sold. In spite of myself, my thoughts drifted back into history, back to what appears to me to be the first organized sales force on record. I refer to the first fishermen of Galilee under the Sales Manager of the Carpenter of Nazareth. They had an idea to sell to the world, and I believe their success stands without a parallel, all things considered. But in connection with the work of this organized sales force, that is the first one as compared to the average sales force of to-day. I think there are two significant facts well worth considering by every man in business. No. 1: This original sales force was not 100 per cent. loyal. One of them betrayed his Master for thirty pieces of silver. How like the average man in business to-day, whose persistent attitude is, "What is there in it for me?" How like the man who will pat his boss on the back, tell him what a wonderful fellow he is, and in half an hour tell someone else a

contradictory story. The Judas stuff—does it pay? Did it pay Judas? The other significant point is that, great as was the success of these twelve men, the real results did not take place until the printing press started to turn out copies of a certain book. I believe that is a fact which will not bear contradiction; and in this same book, this sales manual of the preacher if you will, I believe you can find more sound business sense applicable to the hard-boiled business conditions of to-day than you can find in any modern business volume published. Why, folks, I believe you can get more out of the Book of Proverbs than you can get in the average business school, if you will read it and study it, and use a little imagination along with it. I do not see how anybody can read that Book of Proverbs and not appreciate the fact that old King Solomon, who was supposed to have written it, was some salesman. Why, didn't he have a thousand wives?

They tell us that only about five per cent. of all people who enter into business are successful; that the ninety-five per cent. are failures. I claim that if the man who has good average intelligence and who is about to enter into business would read the Sermon on the Mount, there would be fewer failures. What could he get there? Let us consider the parable, if parable it is, of the house built on the sand. The winds blew, the floods came, and they beat upon that house, and it fell, for it was built upon the sand. And so is the business institution that is conducted by those who are physically, mentally and financially incapable of conducting that business: it will fall every time, for it is built upon the sand. Then let us consider the opposite parable of the house built upon a rock. The winds blew, the floods came, they beat upon that house, and it stood, for it was built upon the rock; and so is the business institution manufacturing a worthy product selling at a reasonable price, in a community for which it has a logical market, by people who are mentally, physically and financially capable of conducting that business, and you can let the winds, the knocks of the competitors, you can let the flood of low prices of the opposition beat upon it, and it will stand, for it is built upon the rock.

How about the parable of the candle under the bushel? You would not place a candle in a bushel, but in a candlestick, that it will give light to all that are in the house. Doesn't that tell us almost in so many words that if we have something to sell which the public should buy that we should tell them about it? For this purpose, we have the newspaper, the billboard, the radio, those innumerable things for the purpose of giving light to all that are in the houses. But how about those who are not in the house? What did the great Sales Manager say? "Go out into the highways and byways and compel them to come in." For this purpose, folks, there is the sales record, the price book, and the folder, with a specific thing to accomplish a specific purpose, with the specific individual: to compel him to come in. Why, folks, I could talk a week. But it all comes back to the one thing: everything has to be sold. There are two kinds

of selling, unmistakably. You can not get away from it—written and spoken. That which is printed, and that which is said. Let us consider for a moment that which is written and printed. How many times do we all make the remark, "Isn't that a beautiful ad.?" The great trouble is too many of them are beautiful, but dumb. It is not the dull, dumb piece of advertising, with the beautiful border, that gets the business, but is the one that tells the people what they want and about the things they ought to buy. And let us consider just a moment the efforts of the man on two feet. Folks, it is not the fellow with the cute neck-tie who gets the order, and I maintain it is not the one with the lowest price, but it is the one who takes the most intelligent interest in the thing his customer is trying to do.

Discussion

Mr. A. B. Scott, Galt : I would like to ask Mr. Griffin how he thinks billboard advertising compares with the newspaper for resale in a small city ?

Mr. Griffin : That is a very difficult question to answer. The billboard has its purpose; the newspaper has its purpose. Either one of them is so constructed that it can send—if such a thing can be done—a buyer direct to your particular place. There are any number of various other kinds of advertising that cannot do that. In other words, you are talking about local advertising in your own community, and you use the billboard or the newspaper. The billboard, of course, is supposed to stand there something like thirty days at least, or more. If there are good localities in your particular community, and the price is anything within reason, in consideration of your particular business, I would say that, in a small town, three or four billboards could be quite profitably used. At the same time, when it comes to a general appeal to the big public, your local newspaper is a wonderful proposition. Although I am not in the newspaper business, still I do maintain that, for all purposes. I do claim that the greatest medium for all purposes considered is your local newspaper. But it will not step out and do the individual thing, accomplish the individual purpose with the individual customer, as will several other forms of advertising. But generally speaking, it is the one big, successful thing that you can use in more places than you can use any other form of advertising, and use it profitably. That is merely my experience.

Development in Line Construction

By E. F. Hinch, Distribution Section, Electrical Engineering Dept. H.E.P.C. of Ont.

(Read before the Association of Municipal Electrical Utilities at Niagara Falls, Ont., June 13, 1928.)

TABLE I, an extract from the 1926 annual report of the Hydro-electric Power Commission of Ontario and its associated municipalities, is intended to show the relative capital invested in the four branches of engineering appearing in a power undertaking. Distribution systems represent 27 per cent. of the total, a rather imposing figure.

With this illustration of the importance of the work of the distribution engineer and the opportunity he has to show results in his capital expenditures, we may wonder why the subject does not come in for more attention and consideration in the technical literature of the profession. Have you ever succeeded in finding a satisfactory and up-to-date text book or hand-book on the subject? There is an almost general interest in the work of the hydraulic engineer, the station engineer and the transmission engineer, but distribution engineering apparently has not the same appeal. There is an answer for this. When we speak of power undertakings, it is of some new larger site to be developed, a generator of still larger capacity to be built or a transmission voltage which exceeds anything that has been used before. The spectacular nature of these achievements calls to each and every one of us. Distribution engineering on the other hand although offering a great variety of work deals with the smaller units and the lower voltages and does not come in for the attention it rightly deserves.

Consider next the amount shown for municipal distribution systems $60,616,620.95. This is in Table II.

In this amount is contained an outstanding figure for overhead systems showing 31 per cent. of the total. This illustrates the importance of the subject chosen for this morning's discussion.

TABLE I.—THE IMPORTANCE OF DISTRIBUTION

	Dollars	*Per Cent*
Generating plants	$124,285,136.44	52
Transmission lines	26,566,320.18	11
Transformer stations	23,108,077.54	10
H.E.P.C. distribution lines	2,064,898.64	27
Municipal distribution systems	60,616,620.95	
	$236,641,053.75	100

TABLE II.—RELATIVE APPROPRIATIONS IN DISTRIBUTION SYSTEM

	Dollars	*Per Cent*
Lands and buildings	6,111,162.54	10
Sub-station equipment	9,505,501.77	16
Overhead systems	18,654,240.54	31
Underground systems	3,689,569.95	9
Line transformers	5,538,605.24	9.9
Meters	5,963,162.51	
Street light equipment	2,413,268.53	4
Miscellaneous construction	3,456,777.71	5.6
Steam and hydraulic plant	628,909.57	1.0
Old plant	4,655,422.59	7.5
	60,616,620.95	100

The object of this paper is not only to bring out discussion but primarily to make a few remarks which will lead each man to think a little more intensely about his own system. It is hoped that you will each be able to see some application of each feature to your own work and that in any case a fresh viewpoint will be given.

Wood pole lines have been constructed for a great number of years and a great deal of thought has been given to their improvement and development. However, there has been a tendency to do things in the same way that they have always been done and it is often rather a task to change the ideas so long held and to actually get the desired excellence of work on some new innovation because so many of those concerned are thinking in terms of the old.

Pole lines were first built to carry telephone and telegraph circuits, later the heavier d.c. circuits, transmission lines of higher voltage and their distribution circuits, railway over head lines and other heavy duties.

Each type of construction must be designed for the duty which it is to perform but there are always certain limitations imposed on the designer to insure the most useful and practical result. Certain assumptions must be made in regard to loading, stresses, safety factor and cost.

Stresses fall into two classes which might be termed internal and external. The internal stresses are those caused by the conductor load, change of direction of line apparatus such as transformers or the weight of a lineman. These are definite quantities that can be dealt with for each line or by setting certain limits when designing a standard line. The stresses set up by external forces such as change of temperature, wind and ice loads are not so easily dealt with. Here we have varying quantities which are beyond our control and it is necessary to assume certain limits. The capital available and the risk one is willing to take both enter into these decisions. Some signal companies apparently assumk that it is cheaper to take the rise of having a line blow down at each very severe storm rather than build

to withstand those storms. The importance of continuous service and considerations of safety are factors which determine largely whether a line should be allowed to come down at all. For instance a transmission line connecting generating plant with a large centre of population should be built against all chance of interruption. Again, all lines are strengthened many times their normal value at points of danger such as railway crossings or when in conflict with other lines. The fact that the very severe storms are not widespread may be taken into consideration and you might be prepared to assume that it would be economical to build all your lines to a standard somewhat less than would withstand all storms and let say 5 per cent. blow down occasionally rather than shoulder the burden of the higher cost on all your lines.

Depreciation must be taken into account for we all know that this is a serious item. What period shall we build for, or, in other words in how many years will a line be so far depreciated as not to be able to withstand the stresses assumed? The various materials used each have a certain rate of depreciation and it is questionable if a design could be so balanced that the line, like "the Deacon's one horse shay", would fall apart all at the one time. Butt rot at the ground line is perhaps the most serious cause of weakening in the line and regarding this much has been done in the last few years of which we shall speak in reference to poles.

An illustration of what happens when you propose various conductors and spans and the effect on the cost is given in the accompanying chart, Fig. 1. The sharp deflections in the curves are due to the necessity of increasing the pole diameter and pole length with certain lengths of span. Standard poles are cut with 6 in., 7 in., and 8 in., tops and in lengths at 5-foot intervals. Thus on the curve for a three phase circuit of aluminum the top diameter of the pole is increased at 200 ft., from 6 in. to 7 in., at 250 ft. from 7 in. to 8 in., and at 325 ft. the pole length is increased to give ground clearance with No. 2 conductor. The loading used in these calculations was ½ inch of ice with a wind pressure of 8 lbs. per square inch on the projected area of the pole and the ice loaded conductor, being the equivalent of a 55-mile gale.

The matter of a choice of voltage for distribution systems has been thoroughly discussed many times before this association and all the merits of the 4000/2300 volt, 4 wire system with grounded neutral have been shown, and at the present time this is a standard in the majority of municipalities. A development has been introduced in our rural distribution where longer feeds are a feature with uniformly distributed loads of the lighter nature. 8000/4600 volts using a four wire circuit with grounded neutral has been found to be applicable to certain conditions of load and area in preference to the common 2200 or 4000 volt or to the higher voltages such as 13,200.

The chart, Fig. 2, shows a comparison of regulation with various voltages for a load of 25 kw. demand at the end of a ten mile line of No. 6 copper. The areas possible to

serve with the same voltage regulation are based on rural conditions of 3 kw. per mile of three phase line and 2 kw. for single phase branches.

4000 Volts, 3 Phase, 3 Wire

In urban districts where secondary bus is strung on almost 100 per cent. of the poles a common neutral is

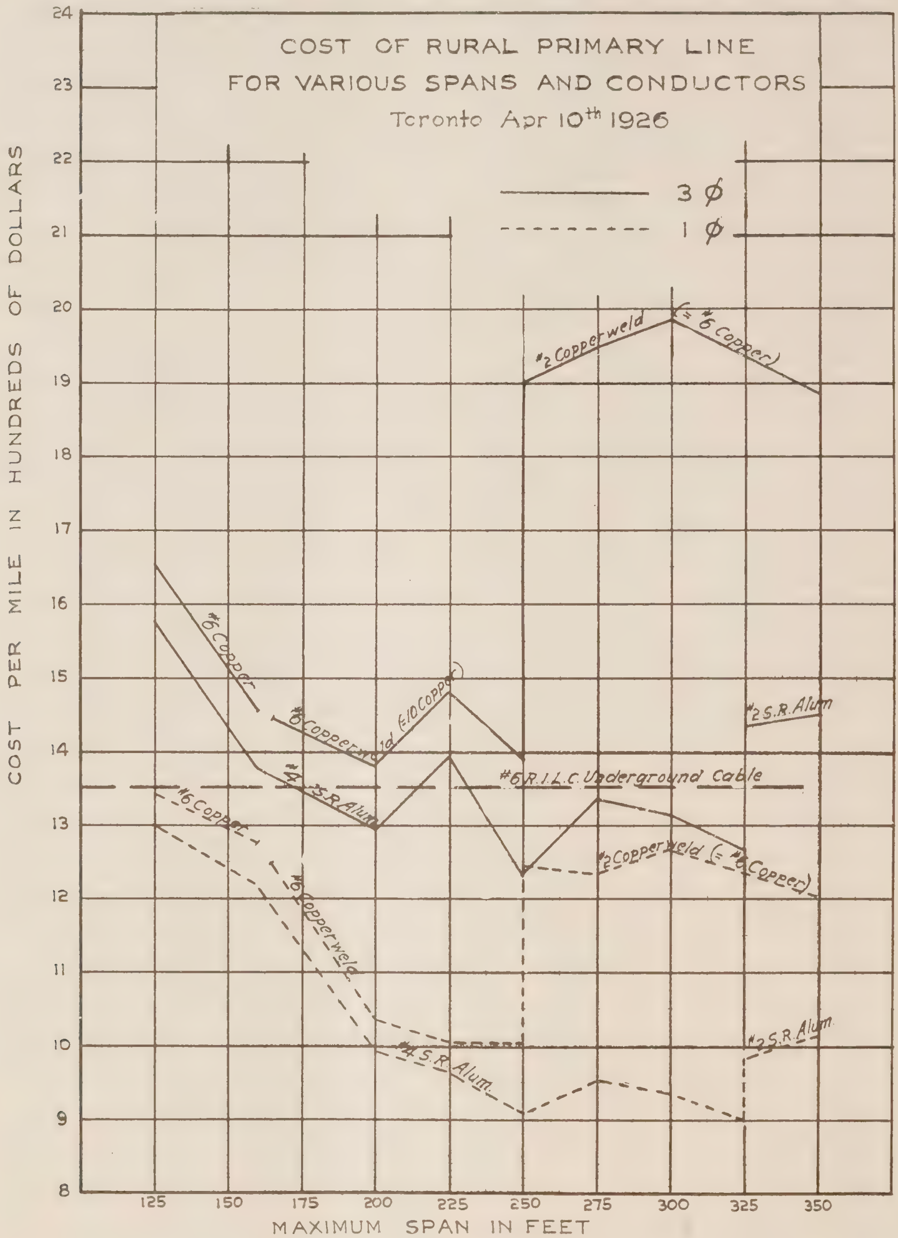


Fig. 1

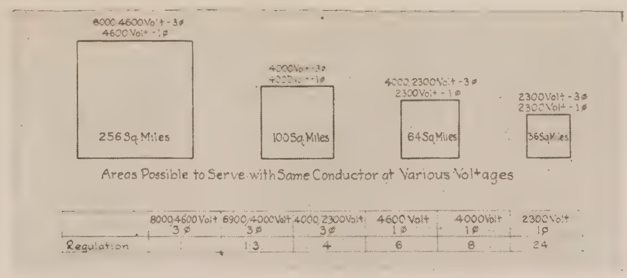


Fig. 2—Comparison of Distribution Voltages.

economical but with conditions such as are met in rural distribution the advantage is not so great. The three wire, 4000 volt line is $116.00 cheaper per mile and will serve a larger territory on account of the single phase, 4000 volt branches.

With the 4000 volt, single phase line three times the load may be carried with the same regulation as with 2300 volts using the same conductor or with a uniformly distributed load the line may be 80 per cent. longer with 4000 volts than 2300 volts using the same sized conductors for the same voltage regulation.

Regarding the equipment for this 4000 volt line, the transformer is somewhat more expensive and two lightning arresters and two cutouts must be used. Taking account of these additional items the increase in cost of the three wire line over the four wire is $65.00 with three transformers per mile. With single phase the 4000 volt line costs $120.00 per mile more than the 2300 volt but the capacity of the line is greatly increased.

8000/4600 Volts

In employing this voltage the area that can be served is about 2½ times that possible with 4000 volts, 3 phase, 3 wire with its 4000 volt, single phase branches for the same conductors and voltage regulation and the same load diversity.

At this point it may be well to detail the advantages of what we might call our universal transformer. This is a two winding transformer 4400/2200 volt primary and 220/110 volt secondary. The transformer has the following applications:—

1. In ordinary 2200 volt service for which a 1900 volt tap is also provided.

2. In service on 4000/2300 volt, 4 wire circuit.
   - (a) Connected phase to ground.
   - (b) Connected phase to phase ungrounded.

3. In service on 4000 volt, 3 wire.

4. On 8000/4600 volt, 4 wire circuit phase to ground.

This transformer is purchased subject to a 17,000 volt test, high voltage winding to low voltage winding and core. The cost even in the smallest size, the 3 kv-a. is only 15 per cent. more than the standard 2200 volt transformer with 10,000 volt test. For 2200 volt service the higher test makes for a better transformer.

The remainder of this paper will deal with new features which we believe to be improvements. In almost every case the development work has been done in conjunction with the manufacturer and we believe that in the majority of cases this is the best way to progress. Very often the inventor's idea may not be practical either in application or from a manufacturing point of view but he can always manage to have it produced if he is ready to stand the production costs. By calling the manufacturer in on the job at an early stage he would discover this cold business view point as to the feasibility of the production of his idea and an early appreciation of what the thing will ultimately cost.

Primary Cut-outs

It was admitted on all sides that dry process porcelain was not a material to be used for cutouts for voltages above 5 or 6 hundred. Several features of the commonly used plug cutout were known to be far from desirable. The one that you will think about first of all is that in inserting a fuse you has a small chance of making a secure connection without reducing the section of the fuse wire or severing it entirely.

About three years ago an idea which had been held for a long time seemed to crystalize and take the form of an insistent demand. We started on the trail of the dry process porcelain cutout on the assumption that it was doomed and that everyone was prepared to pay considerably more for a safe piece of apparatus and that this article must be made of wet process porcelain. It was as the result of this endeavour, mainly on the part of one of our own staff, that the first and the best and the least expensive wet process porcelain cutout was produced about two years ago. Since that time a number of other cutouts have appeared on the market, all of which are better than the old dry porcelain cutout.

The thought naturally occurs at this juncture "What about the thousands of old type cutouts that are still in service?" We believe that a process of gradual elimination will take place. As they fail they will undoubtedly be replaced with a better cutout. During any re-habilitation, and we know that there is considerable work of this nature due at this moment, the new cutouts will be specified for the new construction.

Wood Poles

Eastern cedar poles have been standard material for pole line construction in Ontario except for some urban work where appearance was of prime importance. There are evidences that the supply of these poles is diminishing and that it is becoming more and more difficult each year to obtain the class of pole that you were once able to buy. It is our experience that we cannot purchase poles to-day on the specifications of 1920.

Ontario below the Ottawa and French Rivers is almost out of the picture as a source of supply. Our purchasing agent is forced to range into Quebec and as far east as New Brunswick. A suggested new field is Northern Ontario if the pulp and paper companies can be induced to

cut and float down cedar with their own cut.

In view of this increasing scarcity interest has been stimulated in other woods and in methods of preservation. It is true that pine when properly treated has a lifetime in excess of that of untreated native cedar. Pine is a denser wood, weighs more than cedar per cubic foot and is very much stronger. Lodge pole pine has a very attractive appearance, since it is practically free of knots, symmetrical in taper and uniform in size of butt. Savings in transportation and labour can be made because more of these poles can be piled on a truck when distributing them on the job and the butts being more uniform than eastern cedar there is less variation in the diameter of the hole to be dug. This latter is of more advantage when using an earth boring machine.

new of approximately 1,300 lbs. This becomes less and less as the life of the pin advances due to the difficulty of fitting the locust pin to the fir crossarm. It may be too tight or too loose. The two woods do not shrink or expand at the same rate. The arm may split and in any case rot is bound to appear.

The steel pin of our design when made of the proper grade of steel has a strength of approximately 700 lbs. and is subject to very slow deterioration compared to wood. The grade of steel is important, since the design of the pin is such that it will bend through an arc of 90° without breaking. The steel specified for this purpose is known as intermediate grade billett steel for re-inforcing bars serial designation A 14-15 A.S.T.M. and falls in the class between 70,000 and 85,000 lbs. per square inch in tensile strength.

TABLE III.—CURRENT PRICES FOR 30 FOOT POLES

	Fibre Stress at Elastic Limit	*Circumference at Top*	*Circumference 5ft. from Butt*	*Approximate Price F.O.B. Toronto*	
Eastern cedar.....	3400	19 *in.*	30 to 36 *in.*	7.00	
		22 "	35 to 45 "	8.00	
Western cedar.....	5100	19 "	28 to 30 "	7.25	
		22 "	30 to 32 "	8.75	
Jack pine..........	6000	19 "	28 "	8.50	*Treated*
		22 "	30 "	9.50	
Lodge pole pine....	9000	19 "	28.5 "	9.00	
		22 "	30.5 "	10.00	
Southern pine.....	3380	19 "	28 "	8.00	
		22 "	30 "	10.00	

INSULATOR PINS

After a year's trial we have swung wholly over to the use of steel. Our reasons are briefly outlined as follows :

Black locust pins which are the best obtainable have a strength when

Since this pin has a strength of only 700 lbs. it is not proposed to use it for even the smallest angles. For this duty the clamp pin (Fig. 3) is used up to angles of 60° and from 60° to 90° buckarm construction is employed using a clevis for dead ending:

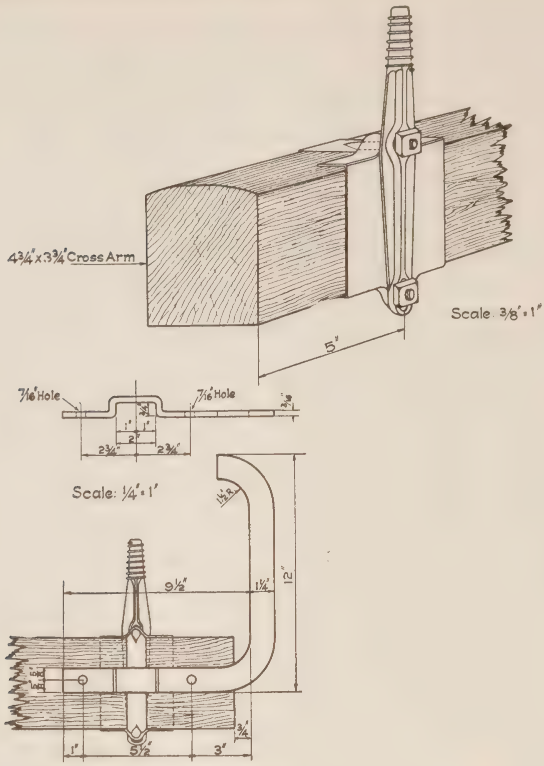


Fig. 3—Steel Clamp Pin and Guard Hook.

Both the clamp pin and the clevis have been developed by our own staff in conjunction with the manufacturer after numerous tests in our laboratories.

The clamp pin is composed of three parts, the pin itself, a strap and a bearing plate. This unit will withstand a pull of 1,500 lbs. in the direction of the line at right angles to the pin or a pull of 1,500 lbs. at right angles to the line. Carrying this test on to destruction at 2,000 lbs. the first permanent deflection of the pin was noted and at 2,500 lbs. the insulator crushed.

The story of the development of the clevis is somewhat different since it was electrical characteristics we were concerned with rather than mechanical. Common type of spool insulators on voltages above 600 will always appear out of proportion in size to the pin insulators used for the same voltage. This is inherent in the design of the insulator since it is not possible to obtain a high flashover characteristic with a small sized spool. We eventually found an insulator (see Fig. 4) that seemed to fit our requirements in flashover and still measured only 3½ inches in length. In attempting to lengthen the distance from conductor to hardware we tried out several ideas such as washers, turning back the ends of

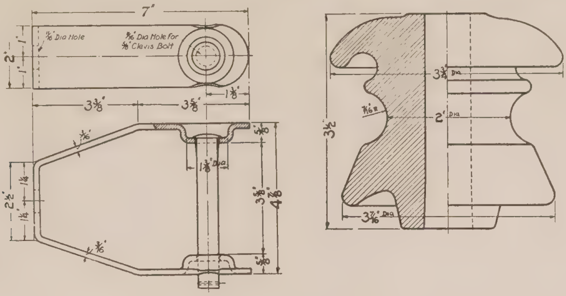


Fig. 4—Strain Plate Clevis and Spool Type Insulator.

the clevis fork and a forged clevis of the horseshoe shape. A boss pressed in the end of the clevis fork was eventually found to be possible in a 3/16 in. strap without excessive cost. The flashover voltage of this unit is 35,000 dry and 15,000 wet. The strength is limited by the insulator which crushes at 1,800 lb. while the clevis will go to 3,400 lb. without bending.

Solderless Connectors

Our 1928 Specifications for secondary work provide for the use of connectors at the following points: (a) Service wires at the bus and at the stand pipe; (b) Transformer leads

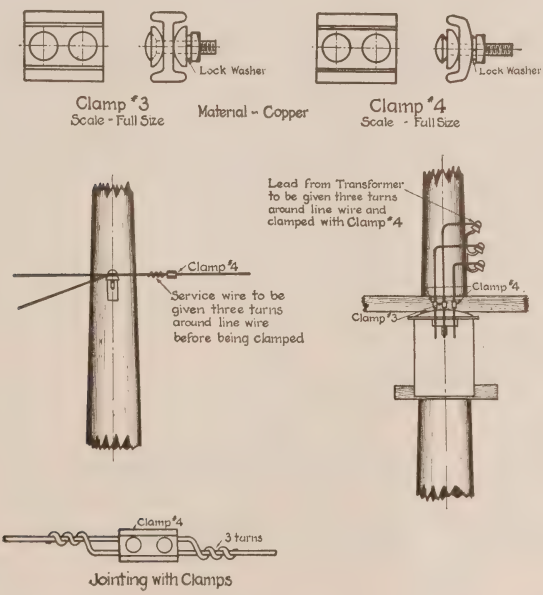


Fig. 5—Details and Methods of Installing Solderless Connectors.

up to 7½ kw.; (c) The tap from the transformer to the bus.

If you were to make a close inspection of your system paying particular attention to joints that you believed to be soldered, how many properly finished jobs would you find? Some when uncovered to the light of day would prove to be entirely innocent of solder. Some others again would show some signs of having had a hot metal dripped over them. Of the remainder not all would prove to be properly fluxed joints.

We believe that a large number of soldered joints made in the air, outside, are not good electrical jobs. Conditions are not right for the work to be done and we consider that anything that will make the work easier and more simple and which can be readily inspected will increase the average quality of the work.

You will note from Fig. 5 that the wire to be tapped onto the line wire is given three wraps about the line wire before the clamp is installed. The three wraps give you the equivalent of a cold joint and take the strain while the clamp provides a large area in contact with both wires.

Grounding

In November, 1926, we measured the resistance of some 38 ground connections of the driven rod type in order to collect information on what might be expected from this sort of terminal in various soils and under various seasonal conditions. The result of these tests showed a maximum of 150 ohms, a minimum of 5.5 ohms and an average for all 38 of 30.2 ohms. As an experiment in treating with salt, the 150 ohm rod which was in a gravelly sand was selected. After

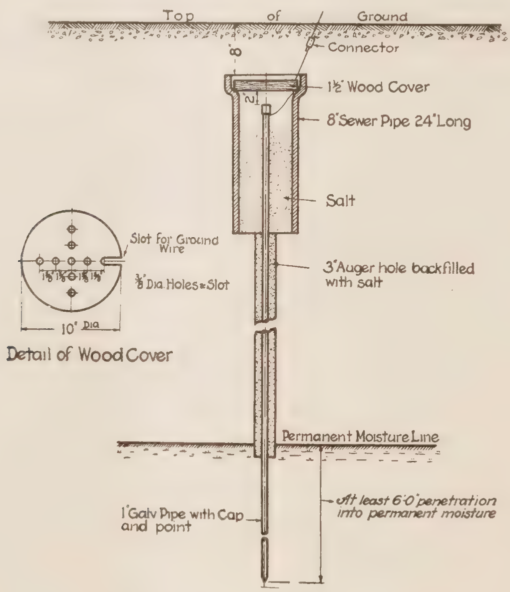


Fig. 6—Installation of Treated Ground.

three days its resistance was again measured and found to be 74.7 ohms.

In February, 1927, we measured the resistance of these same rods and found a maximum of 188, a minimum of 7.9 and an average of 49.1 ohms. This was with a frost penetration of from 13 to 20 inches. The ground terminal which had been treated showed a resistance of only 70 ohms. It is intended that we shall this summer make another measurement to find the effect of a prolonged dry period.

One significant fact demonstrated by these tests is that a very great reduction in the resistance is to be gained by salt treatment and that this improvement is held or even bettered under winter conditions.

A special case was encountered at Wasaga Beach on Georgian Bay, where sand was known to extend to a depth of some 90 feet and where the water is quite pure. On a preliminary test we found that with 2,200 volts applied, no indication of a current flow was shown by the ammeter. By means of an earth auger we went down to permanent moisture and drove a ground pipe some eight or ten feet further. A very high resistance was still obtained, so high that our instruments were off scale.

Fig. 6 shows how these grounds were eventually treated and a single test taken since that time showed a resistance of only 13.2 ohms.

Discussion

Mr. R. H. Martindale, Sudbury: Mr. Hinch mentioned the breaking strain of an insulator, as used on a dead-end clamp, as being 1,800 pounds. I notice there is an insulator on the market now with a lead bushing within the porcelain, which the manufacturers claim has a much greater breaking strain than ordinary porcelain. I would like to ask Mr. Hinch if he has any data where lead bushing has been used on an insulator of that type.

Mr. Hinch: Yes. In that regard, the lead bushing is all right, as long as your pin is stout enough not to deflect. Once you get any bending in the pin, the lead only serves to help the pin to pinch the insulator, and then you get overstresses, then a straight crushing, and the insulator will break more readily at a lower stress. We, in this investigation, sank to the bare pin because we found it gave us better results. One clevis which did allow a movement in the pin was bushed too tightly in the insulator hole, and the insulator cracked at an unreasonably low value, and we didn't want to take any chances with that. We got very good results with the bare pin, 1,800 pounds, and that was our reason for settling on the insulator without a lead bushing.

Mr. F. X. Brady, Toronto: I am very much interested in Mr. H nch's data on lodge pine against the ife of eastern cedar, which he states has a greater life by one and a half times than eastern cedar. Are we to take it that the comparison was made on untreated eastern cedar, or treated eastern cedar ?

Mr. Hinch: I thought I made myself clear, Mr. Brady. Treated

pine against untreated eastern native cedar.

Mr. H. F. Shearer, Welland : Following up Mr. Martindale's question regarding that insulator, was there any deflection of the pin, because of the crushing of the insulator at 1,800?

Mr. Hinch : No. That was a straight crushing between the conductor and the pin.

Mr. Shearer : The pin still held.

Mr. Hinch : The pin was rigid. If you will note, on the drawing, it was a five-eighths inch pin. There was no bending in it, although there might be some small bending in the clevis. Still the pin would not bend at that stress, 1,800 pounds.

Mr. W. E. Reesor, Lindsay : Will you kindly tell us the size of the copper ?

Mr. Hinch : For unbalanced conditions, a No. 2 on one side and a No. 8 conductor on the other could be held quite well.

Mr. O. H. Scott, Belleville : I would like to ask if the manufacturers of transformers have ever considered the advisability of providing a terminal board to save one connection on the transformer on the secondary side ? If they provided some means of bringing the secondary right down into the transformer, it might eliminate one connection there.

Mr. Hinch : The difficulty there is that the leads from the transformer are flexible and for many of your installations you would not want a flexible lead from your transformer to your bus. Whether it is possible or feasible or desirable to run a solid wire from the bus through your bushing and into your transformer board, I do not know. Perhaps one of our transformer manufacturers would say something about that.

Mr. W. G. Brace, Ferranti Electric Limited : I should think one trouble would be the seepage of oil, if we bring the solid wire into the bushing.

Mr. R. H. Starr, Orillia : Some two or three years ago, the Hydro-Electric Power Commission issued a small loose-leaf handbook, and I believe a number of these were purchased. Up to the present, I know that Orillia has not received any new loose-leaves, and I imagine some have been issued, as shown by the photographs to-day. Are any steps being taken to keep these handbooks up-to-date ?

Mr. Hinch : The handbook Mr. Starr speaks of was produced, I I believe, at the request of the A.M.E.U., and they gave us some assurance that a certain number would be sold. We submitted a price of $4.00, and that seemed to be acceptable; but the sale of that book did not develop the way we anticipated, and it would seem, if anything more is to be done with it, that some new funds will have to be provided, by some means or other. That is the reason, I think, nothing has been done with the handbook. I really think that that handbook properly handled would be an asset to everybody, but it would mean constant revision and keeping it up-to-date, both in the text of the book and in the standard drawings, and revisions might even have to be worked into the specifications of materials that change from time to time.

Mr. Martindale : I would like to ask, with reference to the comparison of the red or jack pine pole with the lodge pine pole : is there a great deal

to choose between the two, because red pine is available in all suitable lengths in Northern Ontario, and grows to a nice height and straight. I am using some at the present time. I have it pressure-creosoted and treated, and I would like to know how the merits of that pole compare with the life or efficiency of a lodge pine pole similarly treated. We have not had them in use long enough to know.

Mr. Hinch : I am not qualified to speak of the later developments in the pressure treatment of wood, although I think that would be a very interesting subject. However, I know that some of the later processes —and I think one of them is called the open cell treatment—get a very great penetration in both jack pine and lodge pole pine; any pine, as a matter of fact. The sap wood on the eastern cedar pole makes it difficult to get a real penetration of the preservative. But you will notice on the chart, Mr. Martindale, that the jack pine had a strength on fibre stress at the elastic limit of 6,000 pounds against the lodge pole pine of 9,000 pounds. I will grant this, that the jack pine would have a better butt than the lodge pole pine, and the matter of the size of butt is important, where you have, perhaps, an unbalanced side swing, such as pull offs, and it may be very difficult to balance those strains. The size of the butt, then, would give you a greater area in contact with the ground. The lodge pole pine has a small butt. Its total strength, figuring in the smaller butt, might be down around some of your larger eastern cedar poles, because the total strength of that pole at the butt will be in accordance with the size of the butt.

Mr. J. W. Peart, St. Thomas : I believe it would be of interest to the meeting generally to have Mr. Hinch give us briefly a little more detail on the steel pin that he showed in his slide, and the clamp to the cross-arm. The question of cost is of vital interest, and it would be very interesting to know what the Commission has found when they discarded the use of the locust pin, as to the labour and the cost of installation on mounting these steel pins.

Mr. J. Manning, St. Catharines : I was going to ask if the Hydro have standardized on those steel pins as against the steel pin that goes through the arm. Do they find any shrinkage on the cross-arm, and do you cut the arm at all to let in that steel plate on the side, to prevent the movement of the pin ?

Mr. Hinch : With regard to Mr. Peart's question, I have not the price of that pin with me. I rather think it is something like \$1.12 or \$1.14. The one reason why that clamp pin is used is to save reducing the cross-section of your arm at the pin by boring the hole which you use for the one-inch wood pin. That makes for greater strength in your cross-arm, and you do not take any material out of that cross-arm to fit the plate. The number of those clamp pins used will be according to the number of angles that you have, and if you are scared of the higher costs, there would be very much fewer of those than of the steel pin which we use on the tangents. This is only at angles up to sixty degrees.

Mr. E. G. Flower, Toronto : There are one or two things in favour of that pin which I have noted. First, there are no borings through, which might cause trouble through moisture getting in to the arm. Secondly, provided there is a shrinkage of wood, a lock-washer could be used, which would gradually pick up any loose play through the wood shrinking. Thirdly, the pin can be moved over various voltages. When using a lower voltage, you can shift them over so you will have your wires closer together, or for higher voltage shift them farther apart.

Mr. Brady : I understand Mr. Hinch to state that he uses these only in case of excessive strain of wires. Do I understand that the test was 1,800 pounds right angle strain ?

Mr. Hinch : No, Mr. Brady, 1,500 at right angles to the line.

Mr. Brady : Then my point is this: Are we any further advanced in using a pin of this type than using a double-arm with wooden pin at these points where you have a breaking strain of 1,500 on your pin, and build-up on tensile strength ? I understand you are going to use these on higher strains, and the wood pin on tangents ?

Mr. Hinch : No, the steel pin on tangents.

Mr. Brady : Then, a line properly designed—a tangent line—is under compression rather than side strain. That being so, are we justified, for the extra protection that we get on the side strain, in going to the higher priced pin rather than sticking to the old wood pin and doubling up on points of excessive strain ?

Mr. Hinch : Well, I think, if you will make a little estimate of that, and put your double pin and double arm insulation against the single arm with these pins, that you will come out even or perhaps a little in favour of the single arm with this clamp pin.

Modern Street Lighting

By C. E. Schwenger, Distribution Engineer, Hydro-Electric System, Toronto

(*Read before Association of Municipal Electrical Utilities, at Niagara Falls, Ont., June 13, 1928.*)

THE purpose of this paper is to bring before this meeting some of the outstanding features in connection with modern street lighting practice.

Originally, streets were lighted so that one could see to go about at night, great intensity of illumination was not an important item. Today, however, streets are not lighted for our personal convenience, but to reduce crime, to reduce accidents, to speed up traffic, to increase civic pride, to stimulate business, and other activities, and thereby boom or exploit the city itself. The change in requirement during the last 15 years is largely due to the entrance of the traffic problem. Before that date automobiles were very few, today, we have many thousands of cars on our streets at all times. The requirement of the automobile driver for good street lighting is now predominant. In 1910, let us say, when most Hydro street lighting systems were being designed, there were practically no automobiles, and systems were laid out without this very much in mind. In Toronto, a system using incandescent lamps 100 watts, 80 c-p. mounted only 9 ft. 6 in. from the roadway was adopted. This system was used universally over the city except down town. This mounting height was due to the necessity for placing the lamps below the trimming height of the trees on the streets, this trimming height in those days being 10 feet. There were few asphalt pavements and less than 1,000 cars, and glare to the driver was not a large factor. However, provision was made against glare by the adoption of a translucent cylinder enclosing the lamp which is so evident in Toronto to-day. It soon became apparent that higher mounting heights and greater lamp intensities were needed to take care of the gradually growing traffic. At the present time, the Toronto system uses lamps of 100c-p. at 12 foot mounting height for residential sections, and still it is necessary to use the translucent glass cylinder to prevent glare. On main thoroughfares greater intensities are now used and these will be discussed later.

Modern street lighting practice demands that lamps of increasingly large intensities be used and be mounted at such a height and with definite light control equipment as to

prevent glare to the automobile driver on the highways of our cities. There are two general methods of reducing glare, namely, by increasing the mounting height and also by the use of diffusing or light controlling glassware, and of course, a combination of these.

It might be well to lay down at this point a few of the adopted recommendations of the Illuminating Engineering Society, as presented by their committee on "Street Lighting" 1927, to which other engineering bodies have agreed.

1st. Resolved—That there are no conditions of street lighting prevailing in the United States which justify the use of smaller than one thousand lumen lamps and that the 2,500 lumen lamp is the smallest size which may be used with economy.

Also Resolved—That present day Mazda street lighting lamps rated in lumens are substantially the illuminating equivalents of like types of lamps which previously have been rated in candle power of one-tenth numerical value, e.g., a 1,000 lumen lamp is equivalent to a 100 c-p. lamp.

It is recommended that ratings in candlepower which are now antiquated and in some cases may not be reliable, be abandoned in the few cases in which they still obtain, and that lumen ratings which are now standardized for all series lamps, be adopted in their place.

The "lumen" is the unit of light flux and is that flux of light radiating with unit intensity through a unit solid angle.

Lumen output equals the mean spherical candle power multiplied by 4π (12.766).

Now let us compare available street lighting lamps.

Comparison of Street Lighting Lamps

Type.					Lumens.	
100 c-p.	6.6 amps	69 watts			1,000	"
250 "	6.6 "	152	"		2,500	"
400 "	6.6 "	244	"		4,000	"
600 "	6.6 "	361	"		6,000	"
600 "	20 "	330	"		6,000	"
1,000 "	20 "	540	"		10,000	"
	120 volt Mazda	100	"	"B"	980	"
	" " "	100	"	"C"	1,260	"
	" " "	150	"	"C"	1,950	"
	" " "	200	"	"C"	3,100	"
	" " "	250	"	"C"	3,750	"
	" " "	300	"	"C"	4,840	"
	" " "	500	"	"C"	8,750	"
	" " "	1,000	"	"C"	18,500	"

Knowing the lumens output of the lamps used on various street lighting systems, a convenient way to compare such systems is to do so on the basis of lumens per foot of street. (This does not take into account the efficiency of light distribution on the street).

reflectors, refractors, globes or other controlling mediums.

Now as a further consideration let us take for example the case of street lighting systems using 1,000 lumen lamps bare with no control devices. In such a case the light distribution is practically uniform in all directions

COMPARISON OF STREET LIGHTING INSTALLATIONS

Location of Lighting		*Unit Lumens.*	*Spacing*	*Lumens per foot of street*
Toronto :	Yonge St., down town	8,750 mult.	100 ft.	175
	Sunnyside............	6,000 series	"	120
	Danforth Ave..........	4,840 mult.	"	96.8
	Residential—Double....	1,260 "	"	25.2
	" Single.....	1,260 "	"	12.6
Winnipeg :	Memorial Blvd........	30,000 arc.	"	600.0
	Local Improvement....	10,000 series	150 ft.	75.0
	Residential...........	10,000 "	325 ft.	32.0
Montreal :	New System..........	15,000 series	95 ft.	315.0
Brantford :	Main Streets..........	15,000 "	100 ft.	300.0

Such data does not give a relative comparison of the lumens which usefully reach the street. The amount of useful lumens is dependent on the type and efficiency of the light controlling devices. This may be some property inherent in the lamp itself, such as an arc lamp, which throws most of its light downwards, or on

from the lamp and approximately 50 per cent. of the light flux (lumens) is directed downward, i.e., 500 lumens are available as useful light for street lighting. Now using a good refractor we may catch the upward flowing light and re-direct it in a downward direction.

APPROXIMATE EFFICIENCIES OF CONTROL DEVICES

Controlling Device	*Lamp Lumens Bare*	*Total Lumens Transmitted*	*Downward Lumens*	*Down Efficiency*
Reflector (Radial Wave)......	1,000	866	718	71.8
Refractor (Band)...........	1,000	725	666	66.6
Shaped Translucent glassware..	1,000	760	412	41.2

Bare lamps (without control devices) will give less glare if greater mounting height is used, but this is not practical in most cases on account of trees, and where the unit is of very high intensity it becomes necessary to mount the lamps at a height altogether too great for convenient maintenance. A small bare lamp, 1,000 lumens, must be mounted at a greater height than 15 feet to reduce glare to a reasonable value. Large units such as 10,000 lumens, bare, would have to go at least 30 feet or more from the ground to accomplish the same result.

On the other hand, lighting units using suitable control devices may be mounted considerably lower without producing objectionable glare, thus a 1,000 lumen unit with refractor may be mounted at a height of from 12 to 15 feet, and a 10,000 lumen lamp may be mounted as low as 18 feet. These mounting heights make it possible to illuminate the streets where there are trees, and also to use existing poles or reasonably short ornamental pillars. In addition, still lower mounting heights may be used if good diffusing glassware is used.

The Types and Mounting Heights Used in Toronto

	1,260 lumens	—100 watt	(mult.)	Radial wave Reflector	15 ft.
	1,260 "	—100 "	"	Diffusing glassware	12 ft.
	4,840 "	—300 "	"	" "	15 ft.
	8,750 "	—500 "	"	" "	15 ft.
(Sunnyside)	6,000 "	—600c-p. series refractor and diff. glass.			15 ft.

Other Installations

100,000 lumens,	2-2500 watt (mult) diffusing glassware (Chicago State St.)	22 ft.
15,000 "	Luminous Arc. (San Francisco Market St.)	32 ft.
6,000 "	600 c-p. series, Oneida, N.Y., diffusing globe	11 ½ft.
6,000 "	600 c-p. series, Allantown, Pa, diffusing globe	14½ ft.
2,500 "	250 c-p. series, Mandon, N.D., diffusing globe	12 ft.

Recommended Modern Practice

	Type	*Lumens per ft. of street*
Large Cities 100,000 population or greater	Heavy traffic streets	400 to 1000
	Medium traffic streets	200 to 500
	Residential streets	15 to 30
	Alleys	15 to 30
Smaller Cities	Heavy traffic streets	300 to 500
	Medium traffic streets	200 to 300
	Residential streets	15 to 30
	Alleys	3 to 8
Small Towns	Main business streets	80 to 200
	Residential streets	8 to 15
	Alleys	3 to 8

These recommended intensities are somewhat higher than are used in most parts of the province.

To give some idea of the present tendency in various cities to high intensities may be considered the following :

that of the lamps (120 volts). The series system requires constant current transformers which operate at a comparatively low power factor as compared to constant voltage transformers supplying a multiple system. The power factor on the series

Examples of Street Lighting Intensities

City	*Lumens per ft. of street*
Cleveland (Superior Ave.)	500
Los Angeles (Broadway)	510
Minneapolis (Business section)	520
Portland, Ore. (Business section)	600
San Francisco (Market St.)	750
Niagara Falls, N.Y. (Falls St.)	750
Salt Lake City (Business section)	820
Chicago (State Street)	2,000

system is less than 70 per cent. as against 95 per cent. power factor on multiple system. This low power factor practically cancels the advantage the series lamp has, through greater efficiency, over the multiple lamp.

General Observations

There are two generally accepted types of street lighting systems used, namely, the series system with all lamps on a circuit in series with each other and the multiple system having its lamps connected in multiple on the circuit. There is also a small amount of series multiple lighting.

These systems may be installed either overhead with open wire circuits or underground with lead covered cable which may be installed either directly in the ground or in a duct system.

The series system, as used in Hydro municipalities, has the disadvantage where used overhead of having a small high voltage wire strung from pole to pole and in close proximity to other conductors. The pressure may reach several thousand volts. The multiple system, on the other hand, has a maximum voltage of

There is not much to choose between the series or multiple system in initial capital costs as constant current transformers are several times the price of corresponding constant potential transformers. This increased cost about cancels the saving in series system where only one wire is used for the circuit as against two or three wires used on the multiple system.

While at present there are throughout America a predominating number of series systems, there is a growing percentage of multiple systems being installed, e.g., Minneapolis, Vancouver, Milwaukee, Chicago.

From an operating viewpoint the multiple system has certain advantages. On such a system as used in Toronto, the loss of a street lighting transformer is handled in an emergency by cutting the multiple network clear of the defective transformer and obtaining temporary supply for the street lighting from the house lighting mains which everywhere parallel the street lighting secondaries.

This flexibility does not exist where the series system is used.

With a multiple system extensions may be made with ease as compared to the series system. A wire break or cable fault is not so likely to extinguish all the lamps as would be the case with series lighting.

Extra business, such as advertising sign loads, traffic signs, danger signals, fire alarm boxes, signal lights, etc., are readily supplied by the multiple system without expensive changes to the existing system. These are difficult loads to handle on a series system.

To give some idea of the business exclusive of regular street lighting, which may be added to the street lighting system, the following table is given :

Special Type of Street Lighting

Railway crossings are specially marked by flood lighting arrangement which shows up plainly the tracks and gates, etc.

Traffic police officers are assisted at intersections by means of larger lamps mounted over the centre of intersections. This lighting makes the officer plainly visible to motorists.

Street intersections are also sometimes illuminated with larger lamps mounted at the intersections higher than on adjacent poles. This is a decided convenience to automobile traffic.

Another tendency is that on account of traffic requirements the old moonlight schedule for street lighting hours has become obsolete and a sunset, sunrise schedule is almost universally used.

Where shade trees are newly planted along city streets, the street lighting requirement should receive consideration. In Toronto, the practice of the Forestry Dept. is to plant shade trees behind the sidewalks at intervals of 45 feet. No trees are planted within 45 feet of the street corners. This gives intersections

Business Added to Street Lighting System

For Toronto	*Number*
Advertising signs, 500 k.w. total load	840
Street traffic signs, detours, quiet zone, No Parking, etc.	127
Private lights—apartment house entrances, courts, etc	107
Street Railway, signal lights, for intersections, loops, lavatories, etc	725
School Yard lights (morality lights)	15
Public lavatories	38
Store Front lighting	20 stores
Fire Alarm signal lights	329

clear of foliage when the trees grow up.

This paper touches a few of the important points in connection with the subject, and I trust that included is sufficient material to bring about a good discussion.

Discussion

Mr. G. F. Mudgett, Canadian Westinghouse : I think there is one very important conclusion should be drawn from Mr. Schwenger's paper, and that is, that there is a growing tendency towards the use of larger lamps on higher mountings, and at greater spaces. I think that within a very few years, we will find it the generally accepted practice to mount lighting units twenty or twenty-five feet high, and space them about ten times the distance apart. With the use of light controlling devices and refractors and reflectors, we can obtain uniformity with almost any type of street lighting installation, particularly the two-way and four-way types. Refractors will be very useful in systems of those types. We will probably find that 1,000 watt lamps will be used with an exceptionally high street light, and along with that we will have a lowering of the street lighting cost and less maintenance cost on account of fewer breakages and less cleaning to be done. There is just one other thing Mr. Schwenger mentioned, and that is the tendency towards multiple street lighting. I think series street lighting will undoubtedly be a thing of the past in a very few years. There are all sorts of controlling devices for street lighting, which are just as flexible, and some times more flexible than the series lighting.

Mr. R. H. Starr, Orillia : I would like to ask Mr. Schwenger, when store fronts and sign lights are connected to the street lighting system, does he look after the lamps and charge the same rates as street lighting, or is it on the meter basis ?

Mr. Schwenger : It is on a flat rate, and we do not maintain them.

Opening Address

By J. G. Archibald, Manager, Public Utilities Commission, Woodstock, President, A. M. E. U.

THE President's address will be very brief. I merely want to welcome the delegates whom I see here in such splendid numbers. There are a great many more here than I expected to see on account of the session opening in the morning. The increased interest of the members of the Association in our Conventions is very gratifying to the Executive and those in charge of the Convention work. Our attendance has been steadily increasing at the different Conventions, and I hope, at this one, we shall have established another record. It shows we are getting something out of these Conventions; that is, the get-together spirit is bringing us somewhere. Otherwise, the interest would fall off.

This is an age of Conventions, and a time of united effort. We are realizing more, all the time, that we do not get the best out of anything by individual effort. Only by getting together and rubbing shoulders with the other fellow, getting his point of view and giving him ours, can we accomplish the best in anything. In our Conventions we are brought in touch with the specialist. We cannot all be specialists in everything. At these meetings, we are given an opportunity to hear the men who have devoted their studies to some particular line or have had special success in some particular work. They bring their views to us, and they are of great benefit. We also have the recreational and social side of life, which helps us along. I am sure the time we spend at our Conventions is time well spent, and when we go back to our different municipalities, we go with a better spirit and better fitted for the tasks we have before us.

Minutes of Convention

The twenty-third convention of the Association of Municipal Electrical Utilities was held at Niagara Falls, Ontario, on June 13, 14 and 15, 1928.

The first session of the convention was called to order by the President, Mr. J. G. Archibald, at 10.30 a.m. on Wednesday, June 13th.

It was moved by Mr. R. J. Smith and seconded by Mr. R. H. Starr, THAT the minutes of the last convention as published in the *Bulletin* be taken as read.—*Carried.*

The President gave a short address welcoming the delegates to the convention and commenting on the benefits to be gained by attending.

Mr. E. F. Hinch, Assistant Engineer, Distribution Section, Electrical Engineering Department, H.E.P.C. of Ontario, read a paper entitled "Development in Line Construction," which was illustrated by slides. Discussion following Mr. Hinch's paper was by Messrs. R. H. Martindale, F. X. Brady, H. F. Shearer, W. E. Reesor, O. H. Scott,

W. G. Brace, R. H. Starr, J. W. Peart, J. Manning and E. G. Flower.

Mr. Wills Maclachlan spoke of efforts that had been made for a standard technique in resuscitation in the United States and Canada, and asked that this Association go on record as adopting it.

It was moved by Mr. R. H. Starr and seconded by Mr. R. J. Smith, THAT this Association adopt the technique for resuscitation as outlined by Mr. Wills Maclachlan.—*Carried.*

Mr. C. E. Schwenger, Distribution Engineer, Toronto Hydro-Electric System, read a paper entitled, "Modern Street Lighting." Discussion following this paper was by Messrs. G. F. Mudgett and R. H. Starr.

A hearty vote of thanks to Mr. Hinch and Mr. Schwenger for their papers was moved by Mr. O. H. Scott, which on being seconded by Mr. R. H. Martindale, was *carried.*

The session then adjourned.

At 1.00 p.m. this Association met with the Ontario Municipal Electrical Association for luncheon, when an address was given by Mr. Louis B. Duff, former editor, *Welland Tribune*, Welland, Ontario.

At 8 p.m., the two Associations met for the Convention dinner, which was presided over by Mr. C. A. Maguire, President O.M.E.A. Mr. Edwin R. Weeks, Past District Governor, Rotary Club, New York, Binghamton, N.Y., as guest of the Associations, gave an address.

The second session of the Convention opened at 10.00 a.m. on Thursday, June 14, when Mr. W. H. Griffin, Advertising Manager, Southam Press, gave an address entitled, "Everything must be sold." Discussion following Mr. Griffin's address was by Mr. A. B. Scott.

Mr. G. J. Mickler, Sales Department, H.E.P.C. of Ontario, read a paper entitled, "Electrical Appliance Sales." Discussion following this paper was by Messrs. V. B. Coleman, F. Newman, W. R. Carr, J. J. Heeg, and E. E. Bowley.

It was moved by Mr. J. J. Heeg and seconded by Mr. A. B. Scott, THAT a hearty vote of thanks be extended to Mr. Griffin for his address, and to Mr. G. J. Mickler for his paper.—*Carried.*

The session then adjourned.

At 1.00 p.m. the two Associations met for luncheon, when an address was given by Rev. S. Buchanan Carey, Guelph, Ont.

The third session of the Convention was called to order at 9.30 a.m. on Friday, June 14th, when Mr. J. G. Jackson, Manager, Public Utilities Commission, Chatham, read a paper—"A Proposal for Improved Primary Distribution." Discussion following this paper was by Messrs. C. E. Schwenger, Wills Maclachlan, F. B. Shand, P. B. Yates, A. L. Mudge, R. H. Martindale, H. D. Rothwell, and O. J. West.

Mr. E. T. J. Brandon, Chief Electrical Engineer, H.E.P.C. of Ontario, gave a talk on "Toronto-Gatineau Lines and Station," which was illustrated by slides and moving pictures.

It was moved by Mr. A. W. J. Stewart and seconded by Mr. C. R. Cole, THAT a hearty vote of thanks be extended to Mr. Jackson for his paper, and to Mr. Brandon for his illustrated talk.—*Carried.*

The President gave a short address thanking all those who had assisted in arranging the details of the Convention and thereby contributed towards its success.

Mr. H. T. Gibbs announced that an effort was being made to hold the Canadian Electrical Association and the Canadian Electric Railways Association Conventions next year conjointly at Ottawa, and asked this Association to consider joining in with them.

The proceedings were then closed.

The register shows that the attendance was greater than that of any previous year, there being a total of 350 names, classified as follows :

Class A	79
Class B	116
Commercial	76
Associates	41
Visitors	38
Total	350

There were 259 present at the first Convention luncheon and 274 at the Convention dinner; the attendance at the second Convention luncheon was 234.

The Secretary has received the following note in reply to the telegram of sympathy sent Mr. Hopper from the Convention on account of the death of Mrs. Hopper on June 12 :

Hamilton, Ont.,
June 28, 1928

DEAR CLEM,—

As I visited the Engineers' Club Monday for the first time in several weeks, I did not until then receive the wire you sent from the Convention.

My blow is heavy, but wonderful friends seem to hedge me about and keep me up.

As you know "The Convention" has always been an important event to me, and you cannot realize how gratifying and comforting it is to know that the old A.M.E.U. stopped to think of me in my trouble.

Sincerely,
(Sgd.) CHARLIE HOPPER.

Further Convention Papers will appear in August Number

Electrical Inspection under the Commission in Ontario

(Address broadcasted by Radio recently by a member of the staff of the H.E.P.C. of Ontario)

IN connection with the generation and transmission of electrical energy, the Commission acts as agent and trustee of the *co-operating municipalities.* In so far as electrical inspection is concerned, however, the Commission is the servant of the Provincial Government, and its activities extend to all the municipalities of the Province, whether they are partners in the Hydro undertaking or not.

Object of Inspection is Safety

In brief, the object of electrical inspection is to eliminate the possibility of danger arising through the *misuse* of *electricity.* At the outset I wish to emphasize that, properly handled, electricity *is not* dangerous in the customary acceptance of that term. Compared with the commodities and appliances it has so largely displaced, electricity has many advantages from the safety standpoint.

Owing to the fact that, to the average person, the characteristics of electrical energy are more or less obscure, the ordinary householder is not sufficiently familiar with the technical aspects of electricity to be able to ensure that it is being safely applied and handled. It is for this reason that the necessity for expert supervision exists.

Fire Hazard

You are all familiar, for example, with the fact that when an electrical current is led through the fine wires inside an electric light bulb it produces a very high temperature in the wire. It becomes "white hot." It may never have occurred to you, however, that if a sufficiently large current is allowed to pass through the larger wires that constitute your house wiring, these too will reach a high temperature that could be capable of starting a fire. To prevent this happening, the electrical inspector—when an installation is completed—examines the wiring to make sure that the wires are large enough safely to carry the amount of current required, and also to see that the fuses and other equipment are properly installed.

Shock Hazard

So far as danger of shock is concerned, you know, of course, that electricity, applied under certain conditions, may be fatal, *e.g.*, as employed in the electric chair, where a high voltage is used. Even at the voltage ordinarily used in homes, electricity, if allowed to pass freely *through* the body, can be very dangerous. The electrical inspector, by ensuring that the wires and appliances are properly insulated, safeguards the public in this respect.

Early Action by Fire Insurance Interests

The first authorities to take action with the object of promoting electrical

safety were the fire insurance companies, which about thirty years ago drew up a code of rules for electrical installations.

Government Action

About twenty years ago the Government of Ontario realized that it was important in the interests of the public that safety from *personal shock* hazards as well as elimination of danger of fires from electrical causes, should be promoted. The enforcement of the measures designed to accomplish this purpose was considered to be, properly, a function of public administration, and should be backed by legal authority. In 1912, suitable legislation was enacted.

Powers Given the Commission

In view of the fact that the Hydro-Electric Power Commission already had a highly-trained technical staff of electrical experts, and was, moreover, a body closely affiliated with the Provincial Government, the task of formulating a *Code of Rules and Regulations* governing safety requirements for electrical installations was delegated to the Commission. The regulations were made part of the law of the Province and their enforcement through a system of inspection was also placed in the Commission's hands.

Six years later the Government, through the Commission, provided facilities for testing electrical appliances and materials, and an Act was passed which provided that, unless approved by the Commission as safe for use, no such appliances and materials could be used or sold in the Province. The administration of these regulations is carried out by the Testing and Inspection department of the Commission.

Administration of Inspection Department

For electrical inspection purposes, the Province, at the present time, is divided into some 32 districts, with about 60 inspectors. The work of inspecting installations is under the direction of the Chief Electrical Inspector with headquarters in Toronto, and the work of testing and approving apparatus is the duty of the Approvals Engineer located at the Laboratories of the Commission in Toronto.

The extent of the work of the Inspection department may be realized from the statement that about 90,000 permits are issued annually, authorizing electrical installation and repair work to be done, and about 170,000 inspections are made. These inspections cover work ranging from the installation of a few lights in a small house to the complete installation of power and lighting equipment in large factories, hotels or "skyscrapers."

Rules and Regulations

The work of the Electrical Inspection department is guided by the Commission's Rules and Regulations, which have been specially compiled for the purpose of providing inspectors and electrical contractors with knowledge of certain definite minimum requirements which must be observed. It will be appreciated that each piece of electrical equipment rightly used in any installation is there for a specific purpose. Equipment that would be quite safe in a dry location might be dangerous where

excessive moisture is present. If inflammable material is present, as, for instance, on the stages of theatres, or in garages, special precautions are necessary. In bathrooms, with exposed metal water-pipes, there exists special risk of shock. Insecurely attached wiring and fixtures are a source of danger. For all wires adequate insulation is required. These are only a few illustrations of the many safety precautions that are covered by the rules and regulations.

The first edition of the Rules was issued in 1913. The various requirements are periodically revised to conform to the constantly changing conditions, and in this regard the Commission confers with representatives of the Canadian Fire Underwriters' Association, the Provincial Fire Marshal, manufacturers of electrical equipment, electrical contractors, local municipal commissions and other interested bodies. The last revision of the rules was made in 1924.

Canadian Electrical Code

In recent years, it has been generally realized throughout the Dominion that uniform standards for electrical work in all of the Provinces is much to be desired. With a view to bringing this about, the *Canadian Engineering Standards Association* last year, with the co-operation of the Commission in Ontario and of electrical authorities in other provinces, compiled and published the Canadian Electrical Code, Part I. The best features of the rules at present in force not only in Canada but also in the United States, have been embodied in this Code, and it is generally conceded by authorities throughout the continent that the *Canadian Electrical Code* is a decided improvement on any work of the kind previously in existence in America.

The Hydro-Electric Power Commission of Ontario has adopted this code, which, with some special regulations applicable to Ontario circumstances, has been published as the Eighth Edition of its Rules and Regulations. It is understood that the other Provinces are also preparing to adopt this Code.

Approvals Laboratory

In addition to supervising the installation of electric wiring and equipment in buildings, the Commission, since 1918, has exercised authority with respect to safety requirements *in connection with electrical materials and appliances* sold or used in the Province. Obviously, it would not be feasible for a wiring inspector to carry out the tests necessary to ensure safety in the design and construction of all the materials and devices used in connection with electrical installations. Such work is therefore carried out at the Commission's Approval Laboratory.

Testing of Appliances

Manufacturers, agents, and others handling electrical devices and equipment send samples of their products to the Commission's laboratories, where they are subjected to careful inspection and rigid tests to determine whether or not they are safe for use by the public. If satisfactory, the Commission issues a certificate of approval, which authorizes their sale and use in Ontario. If defective in any essential particular, the manufacturer is notified in what respects

the design or construction needs to be altered before approval can be given.

Detailed test of the samples submitted is followed up by the factory inspection, which ensures that the materials and devices as placed on the market, conform to the same standards as the samples tested.

This work is of service to the manufacturers as well as to inspection authorities in other Provinces. The approval of the Commission is accepted or required in many other parts of Canada.

Ontario Leads in Electrical Inspection

In matters of electrical inspection and approval of equipment Ontario may be said to occupy a position of leadership. Over large sections of the continent the only protection the users of electrical energy have is that afforded by the efforts of the Fire Underwriters, and in some instances by local municipal by-laws or State enactments. Some electrical appliances commonly sold elsewhere have been found to be of such a character that they introduce a very real hazard. The compulsory inspection of electrical installations and equipment in Ontario has undoubtedly prevented a great deal of damage to property and injury to persons.

Safety Precautions

I wish to close this address with *a few cautionary remarks.* If you want to avoid risk of fire and shock—not to mention the possibility of being fined for breaking the law—have your electrical installation and alteration work done by a trained electrician and *inspected.*

Do not use an electric heater in a bathroom, unless you know that the metal frame of it has been properly grounded—that is, connected to the earth through the water pipes.

Do not change lamps or fuses while standing on a damp floor or when near metal pipes or radiators.

Do not use any electrical devices, such as a smoothing iron or toaster, if the flexible cord is frayed or otherwise damaged, or if it begins to spark anywhere. Have the cord repaired at once by a competent workman.

Do not leave an electric iron face downward on any combustible substance, such as a wooden ironing board or table, no matter how soon you expect to be back—remove it. Be sure to disconnect the iron before putting it into the cupboard.

On no account replace a fuse with one of larger capacity than 15 amperes. The capacity is marked on the fuse. This fuse will protect the ordinary house circuit and the use of a large fuse destroys this protection. Never bridge a fuse with a coin or piece of wire.

Purpose of Fuse

The fuse is the safety valve of the electrical installation. If, through defects in the wiring or the appliances used, a large current is permitted to flow, the wire in the fuse melts and shuts off the current before any damage can be done. It is, therefore, important that a fuse of proper capacity be used, otherwise it may not cut off the current when it should and serious damage may result.

While the law requires, as has been stated, that only approved devices be sold in Ontario, unscrupulous

persons have at times attempted to sell devices embodying dangerous feature. You can assist the Commission and at the same time promote the safety of your person and property by buying only approved devices. In case you are in doubt at any time enquire of the nearest Electrical Inspection office.

Finally, if you have any reason to think that any part of your electrical installation is defective through age or any other cause, apply to the Electrical Inspection department for advice as to what should be done with it. At nominal cost to yourself you may thus be able to avoid much trouble and inconvenience, if not actual bodily harm or loss of property.

The Commission is always at work to secure more efficient equipment for, and safety to, the public.

Sources of Power

FROM time to time the popular press and occasionally even an engineering publication start talking about some new kind of prime mover operated by electricity taken from the air or a new combination of windings, or by some radically new form of energy. Even engineers are beginning to consider as a possibility the utilization of energy liberated in some as yet obscure manner by the breakdown of the atom. In view of all this it becomes of interest to consider just how and why the sources of energy that are used in present engineering are available.

The earth on which we live is very, very old. The more we learn about it the further back are shifted its beginnings. Where fifty years ago science talked about the earth's age as being of the order of 1,000,000 to 5,000,000 years, today geologists confidently put its age at a minimum of 100,000,000 years, and there are already reasons apparent to make it believable that even this span of time is a low estimate when it comes to the true age of the earth.

During this enormous period of time even very slow chemical and physical reactions could have been accomplished. We find, therefore, that wherever a material could have combined with any other material in its immediate neighborhood, it did so combine. This is the reason why most of the ores are found in the form of sulphides, phosphides, oxides, etc. Virgin iron is practically unknown ; virgin copper is met in only a few places where protection chiefly by sand kept away from it all those other elements that would have been willing to enter into a combination with it.

Another very significant feature of the chemical composition of the earth's crust is that, whenever possible, materials are encountered therein not in their intermediary unstable or semi-stable combinations, but in the most stable form, thus indicating that whenever possible, chemical action continued as long as it could. Chemically (with such exceptions as

will be noted below) the earth's crust is in a state of stable equilibrium.

When we consider the same crust mechanically we again find a clear tendency toward the same stable balance. Today "even the weariest river runs safely to the sea." This was not so always. Geologic formations indicate that in days far gone by there were wide lakes opening into huge waterfalls. About 100 miles from the present ending of the Hudson River the sea bottom shows traces of a big waterfall into which this river formerly discharged. As millions of years followed each other, however, the surface wore down, and where there was an abrupt change of level formerly, today mostly a uniform descent is only to be seen. There are still a few waterfalls here and there, Niagara Falls in North America, Imatra in Finland, the Victoria Nyanza in Central Africa, but these are simply survivals of a distant age, and for example, the Niagara Falls, even within the brief memory of the white man on the American continent, has lost some of its height of fall. The general mechanical tendency in nature is to accomplish within wide limits the same state of balance as is observed in the chemical composition.

What sources of energy have hitherto been available to humanity in large quantities may be said to be those which have been specially locked up within the earth's crust. There was a time when practically the entire face of the earth was covered by luxurious vegetation. This has been, however, burned, rotted, or otherwise destroyed by oxidation, either violently induced or of slower process as under water, or in a modified form by the action of bacterial life. It is only here and there that primeval forests have been covered over by layers of earth in such a manner as to prevent the access of oxygen thereto. From the point of view of chemical history of the earth this was an irregularity, because combinable carbon did not enter into such a combination with oxygen as would bring the two to the most stable form. When we dig out the coal, place it under boilers, and burn it to carbon dioxide, we accomplish for a commercial purpose the very same thing that has been going on for some purpose unknown to us during all of the hundred million years of the history of the earth.

In other words, we can generate power only by finding in nature some thing that has not yet reached its most stable condition, and helping it to do so. It so happens that all such reations are exothermic, which means that they produce energy rather than consume it. That is what happens when we burn coal under a boiler or explode a mixture of oil and air in a cylinder. The only reason why nature has not done it before we had a chance to is that the two materials whereof the reaction produces heat or energy have not been sufficiently close together. Coal and oil have been protected underground from the action of the oxygen. We bring them up and place them in contact with that oxygen, whereupon the reaction takes place with its consequent generation of power.

When we come with the above in mind to the consideration of the so-called interatomic energy and con-

sider, for example, the simplest molecule, namely, that of hydrogen, we see that while a hydrogen molecule represents something (electrical charges or waves) in extremely rapid motion, it also represents an extremely stable system. The stability here is dynamic instead of static, but of a very high order nevertheless—so high in fact that hitherto no matter how much energy has been applied to it this stability has not yet been upset. While we do not know very much about the true structure of the hydrogen atom or indeed the atom of any other element, it would be reasonable to expect that since very nearly everything else in the earth whether chemical or mechanical has reached a state of equilibrium, the atom, which is the foundation of the whole structure of matter, must have also reached a high degree of stability or equilibrium. This would lead one to believe that as little energy can be produced by the breakdown of an atom in any of the common elements encountered on the earth as there can be produced energy by trying to burn, for example, carbon dioxide. True, there is good reason to believe that the enormous amount of heat given out by the sun is the result of the breakdown of atoms, but there we are dealing not with the common elements, such as hydrogen, carbon, nitrogen, and the like, but with an entirely different group, namely, radioactive elements, which are apparently elements that have not yet reached the stage of interatomic stability, and of which hitherto only insignificant traces have been found on the earth. If this is so, then there is only very little hope for obtaining energy from the breakdown of any of the atoms known to occur in quantity on the earth.

When we come to the question of fuelless motors and the like, it will be well to bear in mind that the only way known to us by which industrially applicable power can be generated is to find in nature something which represents chemically or mechanically a lack of balance and to carry out the reaction which will create that balance, be it by piling up water by means of a dam and letting it fall to a much lower level, or by bringing up from under the ground a fuel. There is no way of obtaining energy without some such effort, because all generation of energy represents either a mechanical or chemical reaction tending to bring things of the earth into a state of balance, and had the elements of this reaction been lying side by side ready for combination, they would have combined in the 100,000,000 years that our planet has been in business.

—*Mechanical Engineering.*

It Hurts Me

I am very much opposed to this thing of the young people sitting around in the dark. It is all wrong. The first thing that happens when a young man calls on a girl is the turning off of all the lights in the room, and then anything is liable to happen. Nobody knows what is going on but them, and they don't give a darn. Certainly it is a matter which should be looked into. It is a thing that causes me much concern. I am thankful to say that I am no reformer, neither am I the father of any of the

younger generation—of which I am still more thankful. I object strongly to the practice for the one reason that, while it may be nice for them, it isn't good for me.

I am the local manager of the Light and Power Corporation.—*The Circuit.*

H.E.P.C. Staff Picnic

The annual staff Picnic of the Hydro-Electric Power Commission of Ontario was held on Tuesday (July 10th) at Port Dalhousie, under the direction of the Ontario Hydro-Electric Club, and was participated in by the Toronto Head Office and Strachan Avenue Staffs, as well as a large delegation from the Niagara Falls and Hamilton staffs. The officials are not yet complete, but the attendance was approximately 486 adults and 210 children from Toronto, 324 adults and 177 children from Niagara Falls, and about 20 adults from Hamilton, making the total attendance approximately 1237.

This has been pronounced the most successful Picnic of any yet held by the Commission's staff, not only from an attendance standpoint, but in every other respect. The weather was ideal and the location everything that could be desired for an affair of this kind.

Entertainment was provided for on the boat in the nature of dancing for the adults, and numerous favors for the children, with music provided by the Hydro-Electric Power Commission's Club Orchestra, assisted by Mr. George Ketiladze, as special pianist.

An excellent program of sports was provided by the Sports Committee, races of all kinds and for all ages being arranged for.

The Tug-of-War was won by the Hamilton staff from Toronto, after a very close and exciting contest, but Toronto secured its revenge in the Soft Ball contest, defeating Niagara Falls 24 to 6, and Hamilton 16 to 3.

A large number, of all ages, also took advantage of the excellent bathing beach at the Picnic grounds and this particular feature was very much enjoyed and appreciated.

A great deal of credit is due to the refreshment Committee for the excellent manner in which they carried out their duties, and as a Picnic of any kind is largely dependent upon the efforts of such a Committee too much praise cannot be given to those responsible for that portion of the day's outing.

The officers of the O.H.E. Club by which the Picnic was conducted are as follows:—President, Mr. C. C. Bodley; Vice-President, Mr. J. C. Wills; Secretary, Mr. H. J. Ayris, Treasurer, Mr. R. C. McCollum, Messrs. O. Holden, W. B. Buchanan, H. D. Rothwell, H. E. Brandon and T. C. James—Misses Hartwick and Ferguson, with the special Committees directly in charge of the Picnic program being as follows:—Entertainment Committee: Mr. T. C. James, Chairman; Miss Ferguson, Mr. J. C. Wills; Transportation Committee: Mr. W. B. Buchanan, Chairman; Sports Committee: Mr, T. H. Hogg, Chairman. With Mr. Bruce Black as special Deputy in charge of the proceedings. Refreshment Committee: Mr. E. T. J. Brandon, Chairman. With Mr. H. Waddingham, Deputy in charge of proceedings.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Power Factor in the Office

By W. D. Stalker, Secretary, Simcoe Public Utilities Commission

THE Town of Simcoe has had the same rapid electrical growth as like Hydro municipalities in Ontario, but while substation and line had been extended and rebuilt, for ten years the Office had stood still. It was thought, therefore, that the Office would soon have to be enlarged and the staff increased. However just as the regulation of loads may improve distribution conditions to such a degree as to save the installation of additional station capacity, so too in the Office the correction of "office power factor" may save the employment of more "prime movers." This was tried in the Office of the Simcoe Public Utilities Commission with rather remarkable results.

Office Plan

Advantage was first taken of a general change in the municipal building to so design the billing and collecting office that the best layout for local conditions might be obtained. During the alterations a temporary arrangement for collecting proved so convenient for posting also, that the idea suggested itself of embodying the posting desks with the counter inside the wickets. The final result has not only saved steps and time for the office staff but also the public is more quickly served.

Addressograph

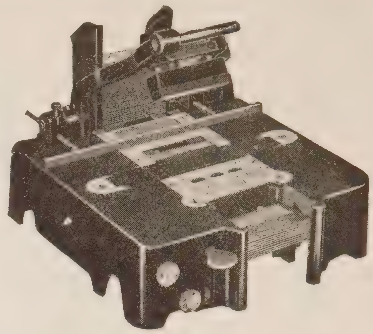
It had been standard practice to make out and address all hydro and water bills by hand, using a postcard type of bill. An addressograph and graphotype were now added to the equipment and a great time saving in addressing was made immediately. Parenthetically, it may be remarked,

CONTENTS

Vol. XV **No. 8**

August, 1928

	Page
Power Factor in the Office - -	253
Electrical Appliance Sales - -	258
A Proposal for Improved Primary Distribution - - - - - -	281



Hand Operated Addressograph

that while at first somewhat dubious about the wisdom of purchasing a graphotype, this machine saved a considerable part of its cost by enabling the local staff to make all the originally necessary plates or stencils, as occasion presented, at small cost, and is now invaluable for change-over and new services.

Straight Line Bill

The full advantage of the addressograph equipment was not realized however until the old card supply was exhausted and use of the "straight line" bills was commenced. For both Hydro and Water, these were designed by the H.E.P.C. Municipal Auditor, Mr. McCollum. The only continued criticism made of this straight line bill, has been by a school teacher, who objected to the number of times the word "bill" appeared. The answer is,

NOTICE—THIS BILL MUST ACCOMPANY REMITTANCE
PAYABLE AT THE CLERK'S OFFICE, SIMCOE

SIMCOE HYDRO-ELECTRIC SYSTEM

Name .... Service No. .... Service No. ....

Meter Readings: Date .... Date ....

Present .... Last	Service Charge	....	....	Service Chg.	....	....
Consumed	K.W.H.	....	....	K. W. H.	....	....
1st Rate	K.W.H. at c	....	....	1st Rate	....	....
2nd Rate	K.W.H. at c	....	....	2nd Rate	....	....
Amount For Month		....	....	Total	....	....
Less 10 p.c. if paid on or before the 10th inst.		....	....	Discount	....	....
Net Amount of Account		....	....	Net Bill	....	....
Arrears, No Discount Allowed		....	....	Arrears	....	....
AMOUNT DUE				Amount Due		

OFFICE HOURS:—9 TO 12, 1 TO 5, ON 10th OF MONTH TO 6 P.M.

Post Card type of Bill used for lighting service prior to adoption of present System.

SIMCOE PUBLIC UTILITIES COMMISSION
58 PEEL STREET, SIMCOE, ONT.

THIS BILL IS DUE WHEN RENDERED. Unpaid Bills will be Collected According to Public Utilities Act

Date	Present Reading	Previous Reading	Consumpt'n	Consumpt'n Charge	Service Charge	Gross	Net
						Arrears	
						Total	

This Bill is for **Two** Months From Meter Reading Date on Previous Bill, Unless Stated Otherwise Here...............Months
Installed Capacity...............................Watts.

THIS BILL SUBJECT TO METER OR CLERICAL ERRORS.

Payable at Clerk's Office
58 Peel Street

Office hours:
9-12 a.m., 1-5 p.m.

For details of billing see back of bill.

SIMCOE PUBLIC UTILITIES COMMISSION
HYDRO LIGHTING SERVICE
Mail stub only when paying by cheque.
If receipt is desired, enclose postage for return

Gross	Net

Account

Last Discount Day
10th

Straight Line Bill now used for lighting service

however, that the reiteration automatically draws the bill-fold from the customer's pocket and painlessly extracts the required number of bills to pay the bill before the discount date.

Computer

The use of a Bates Index, with ribbon for computing domestic hydro bills without figuring them, has also proved a valuable time-saver. The bills are first run through the addressograph which puts the complete address including service number, on both bill and stub at one operation. They are then typed directly from meter sheets, the amount of the bill being read off the Index or Computer, and the lay-out of the bill is such that all typewritten figures are in one *straight line*, so that no extra setting of the typewriter roller is necessary. The meter reading and amount of the bill is entered on the ledger card by hand at the same time. By taking the readings from the meter books the bills are kept in the correct rotation for subsequent delivery, saving time formerly spent sorting. The addressograph plates are of course kept in their trays in the same order as the meters are read, so that proper plates feed into addressograph automatically.

Off-Peak Time

The addressing of all bills and also the dating with a rubber stamp is done ahead of time in "office-off

SIMCOE PUBLIC UTILITIES COMMISSION
WATERWORKS DEPARTMENT

THIS BILL IS DUE WHEN RENDERED Unpaid bills will be Collected According to Public Utilities Act

Date	Present Reading	Previous Reading	Consumpt'n	Consumpt'n Charge	Meter or Flat Rate per Quarter in Advance	Gross	Net
						Arrears	
						Total	

This Bill is for **Three** Months from Meter Reading Date on Previous Bill, unless stated otherwise here....................Months

The consumption charge is 15 cents per 100 cu. ft.

The By-law provides that if this Account is not paid within 15 days after the date rendered, water shall be turned off until arrears and charges are paid, including an additional charge of 50 cents for turning off and on.

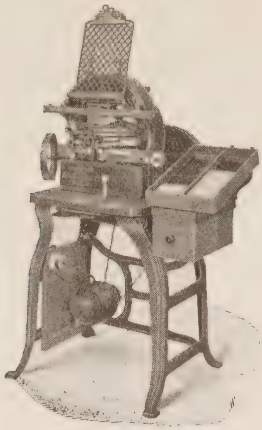
SIMCOE PUBLIC UTILITIES COMMISSION
WATERWORKS DEPARTMENT
Mail stub only when paying by cheque.
If receipt is desired, enclose postage for return

Gross	Net

Account

Last Discount Date
15th

Straight Line Bill now used for water service.



Graphotype for preparing addressograph plates

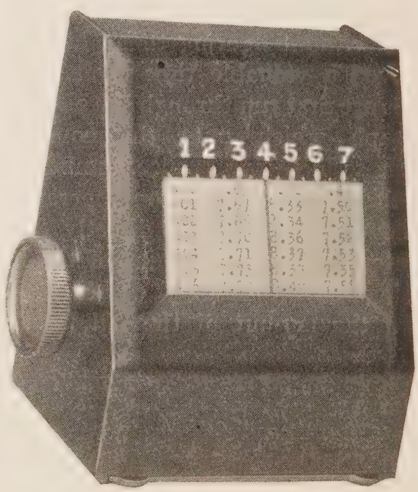
peak" hours. This has helped flatten the monthly office load curve, and there is but a small "valley" between billing periods. Even this "depression" may be overcome by having the last discount date for Hydro bills the 10th of the month and giving until the 15th for Water accounts. This "staggering" has just been inaugurated, and so definite results have not yet been obtained.

Side-Opening Meter Books

Not content with the foregoing changes, side-opening meter books were also recommended. They were accordingly purchased and have not only been approved by the meter man but have been endorsed by the office staff. The office saving is particularly noticeable in billing the domestic hydro accounts when meter books, cards, computer and typewriter are all used together.

Meter Department

Due to the small size of the system it had previously been the custom to use a lineman for the necessary time each month reading hydro meters, and a man from the Waterworks Department to make their quarterly water reading. This has now been combined under one meter man, who reads all meters both hydro and water, and if time permits, delivers the accounts. This arrangement has not only effected a saving in cost but is more satisfactory to all the departments. The outside hydro work is not interrupted, the water work is not inconvenienced, and the office is in closer touch at all times with the meter department. On some routes both hydro and water meters are read at the same time which has not only resulted in a time saving but has proved more satisfactory to the customers who are thus subjected to fewer calls and less change in personnel.



Bates Index adapted as a computing machine for domestic electric service. The red line on the tape approximates the kilowatt-hours, shown in the left hand column. The other columns from right to left in order show gross kw-hr. charge, gross bill and net bill.

RESULTS

As these changes have taken place successively the credit due each factor has been noted and the results tabulated:—

HYDRO—

Billing periods		
Old System	54	hrs.
New "	29	"
Saving	25	"
Allotment of Saving		
Office Plan	7½	hrs.
Addressograph	12	"
Straight line bill	2	"
Computers	3	"
Side-opening Meter books	½	"
	25	"

WATERWORKS—

Billing Periods		
Old System	126	hrs.
New "	54	"
Saving	72	"
Allotment of Saving		
*Office Plan	38	hrs.
Addressograph	31	"
Straight line bill	3	"
	72	"

*The large saving allotted to office plan is by reason of a more convenient arrangement of the waterworks ledgers, three ledgers being used simultaneously.

ABSIT OMEN

Astonishing as results have been, a continued study with a view to further time saving reveals that the limit has even yet not been reached. A better wicket lay-out, a further use of computing charts, and the installation of power driven equipment will eventually, be necessary as the increase in the municipality again loads the office to 100 per cent capacity.

In this age and in this country who can say when a limit has been reached, or provision made very much ahead of the requirements of the immediate future, and nowhere is this so marked as in Hydro-electrical development. As we climb the Mountain of Canadian Progress the limiting horizon constantly recedes, and there is vouchsafed an enlarging vision of increasing vastness.

Copies of the straight line bills as used by the Electric and Water Departments are shown, as well as illustrations of the Bates Computing Index and the hand operated Addressograph and Graphotype.

Electrical Appliance Sales

By G. J. Mickler, Sales Department H.E.P.C. of Ontario

(Read before Association of Municipal Electrical Utilities, at Niagara Falls, Ont., June 14, 1928.)

FOR the past five or six years I have been collecting data on the use and sale of the more important electrical appliances among Hydro consumers in Ontario, and each year have published these data to show how the public in Ontario were taking to the conveniences offered by the electrification of the home and what Hydro Shops have contributed in the way of sales to bring about the complete electrification of household labours.

Since 1924 questionnaries have been sent out to every Hydro municipality asking for information as to how many of each of twelve major appliances were sold by that municipality if a Hydro Shop was being operated; also an estimate or figures developed from an actual survey to show how many of these appliances were being used by Hydro customers.

This information was all compiled and by applying the law of averages an estimate was prepared each year to show the total number of appliances in use by all Hydro customers and the percentage saturation. During the first year or two a great many of the figures submitted were based on estimates, but lately the majority of the municipalities have been taking sufficient interest in such statistics to make an actual survey and count the number of appliances in use, and it is felt that the figures submitted as of December 31st, 1927, give a pretty fair indication of the use that was being made of appliances among Hydro consumers at that time.

As sufficient information has now been gathered to permit of comparisons being made over a period of years, I thought it would be interesting to show the growth of use of electrical appliances in some of the larger municipalities during the last three years, and also to show how many of these appliances Hydro Shops in these municipalities have been selling during the same period, and I have prepared tables which follow, which contain some very interesting information.

It was the intention at first to list all of the Hydro municipalities in which a Hydro Shop is being operated and develop statistics for each of the appliances under consideration, but on examining the data which have been received during the past four years it was found that in some cases an incorrect estimate of the number of appliances in use in 1924 or the lack of such an estimate or actual count prevented the use of these figures with those that came in 1927.

TABLE No. 1.

DATA ON ELECTRIC RANGES IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Ranges			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton	399	455	56	32	66	34	34
Border Cities	17,458	22,509	5,051	8,400	16,989	8,589	4,685
Belleville	2,800	2,779	−21	325	550	225	167
Bowmanville	850	929	79	195	260	65	49
Chatham	3,517	3,727	210	400	600	200	74
Exeter	358	421	63	68	102	34	32
Forest	400	439	39	14	51	37	31
Galt	3,289	3,281	−8	1,300	1,615	315	271
Goderich	1,181	1,061	−120	60	133	73	40
Guelph	4,332	4,634	302	244	604	360	43
Hamilton	24,556	27,642	3,086	3,299	6,574	3,275	1,373
Kitchener	4,895	5,813	918	245	1,602	1,357	340
London	14,957	16,065	1,108	4,000	6,500	2,500	997
Midland	1,385	1,541	156	164	291	127	107
Mitchell	393	427	34	62	93	31	38
Napanee	650	715	65	190	279	89	16
North Bay	2,506	2,881	375	386	540	154	43
Owen Sound	2,548	2,846	298	166	316	150	30
Picton	816	911	95	38	105	67	49
Sarnia	4,176	4,298	122	700	1,100	400	230
St. Marys	904	981	77	202	300	98	60
Stamford	869	1,193	324	140	528	388	331
Stratford	4,036	4,174	138	1,500	2,030	530	359
Strathroy	681	731	50	116	182	66	66
Toronto	109,299	130,551	21,252	7,000	12,835	5,835	1,844
Trenton	1,100	1,117	17	100	143	43	24
Woodstock	2,409	2,603	194	577	904	327	117
Perth	714	796	82	51	111	60	54
Totals	211,478	245,620	34,520	29,974	55,403	25,431	11,504
			Increase 3 years 16.3 %		Saturat'n 22.8 %	Increase in 3 yrs. 85.1 %	Sales 45.4 % of 3 yrs. Increase

Also, as a number of Hydro Shops do not sell all of the appliances under consideration, comparative figures would be misleading. Then again, there are some so-called Hydro Shops which are not aggressively engaged in merchandising and figures from such municipalities do not shed a true light in comparison with those of municipalities where an up-to-date shop is being conducted and volume sales effected.

In preparing these tables, I have shown the growth in the number of domestic consumers served during the three years 1925, 1926 and 1927, and have shown also the growth in the number of appliances reported in use in the same period and compared the increase in the number of appliances with the total number sold by each Hydro Shop.

Table No. 1 on *Electric Ranges* gives the details on 28 municipalities. In these there was an increase of 3,452 in the number of domestic consumers served and during this period of three years there was an increase of 25,431 in the number of electric ranges installed of which 11,504 were sold by Hydro Shops. In these 28 municipalities the saturation for electric ranges is 22.8 per cent. The increase in use is 85.1 per cent. over that of 1924, and Hydro Shops sold 45.4 per cent. of the total number installed during that time.

An interesting feature of this table lies in the fact that the increase in the number of ranges installed is just a little over two-thirds of the increase in the number of domestic consumers served. This would indicate that the electrical industry was to some extent falling behind in its effort to sell electric cooking. It is fair to assume that a new customer is a better prospect for an electric range than an old customer, as the majority of new customers who apply for service occupy new dwellings or apartments which are adequately wired, permitting of the installation of ranges without undue installation costs. While figures are not available, it is safe to assume also that the majority of ranges installed during the last three years were placed in new dwellings. These figures show therefore that very few of the older customers on the lines in these 28 municipalities have been induced to discard their antiquated and inconvenient means of cooking for the electric range.

Of course in some of the muncipalities the figures show that a great many more ranges are being installed than there are new customers being added. In growing centres like the Border Cities, Hamilton, London Sarnia, Stratford, and Woodstock this appears to be the case.

Table No. 2 on *Electric Hotplates* gives the details on 19 Hydro Shop municipalities, and in these the total number of consumers added in the three years amounted to 8,956, or an increase of 14.9 per cent. The increase in use reported amounts to 3,490, or an increase of 110.5 per cent in three years. Hydro Shops sold 1,489 or 42.7 per cent. of the total number installed in the three year period. As an electric hotplate is not considered adequate for electric cooking, and is usually an adjunct to an electric range being used in the laundry, and further as a hotplate is not always considered necessary par-

TABLE No. 2.

DATA ON HOT PLATES IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Hot Plates			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton........	399	455	56	29	51	22	22
Border Cities.	17,458	22,509	5,051	1,340	2,938	1,598	711
Belleville.....	2,800	2,779	−21	40	69	29	17
Bowmanville	850	929	79	260	355	95	63
Chatham.....	3,517	3,727	210	200	350	150	81
Forest.......	400	439	39	10	20	10	11
Goderich.....	1,181	1,061	−120	15	112	97	6
Kitchener....	4,895	5,813	918	57	394	337	90
London......	14,957	16,065	1,108	500	950	450	186
Midland.....	1,385	1,541	156	208	301	93	75
North Bay...	2,506	2,881	375	105	140	35	8
Owen Sound..	2,548	2,846	298	76	281	207	13
Petrolia......	581	631	50	5	25	20	10
Picton.......	816	911	95	32	75	43	36
St. Marys....	904	981	77	61	114	53	35
Stamford.....	869	1,193	324	13	108	95	30
Strathroy....	681	731	50	22	50	28	26
Trenton......	1,100	1,117	17	100	155	45	37
Woodstock...	2,409	2,603	194	85	160	75	42
Totals...	60,256	69,212	8,956	3,158	6,648	3,490	1,489
			Increase 3 years 14.9 %		Saturat'n 9.7 %	Increase in 3 years 110.5 %	Sales 42.7 % of 3 yrs. Increase

ticularly if a suitable hot water heating device is in use, no particular significance is attached to the falling-off of sales of hotplates as compared to the number of customers added to the lines, but these figures are submitted for the information of those who may be interested.

Table No. 3 on *Electric Water Heaters* gives information on 24 Hydro Shop municipalities. In these there was an increase of 9,709 in the

number of domestic consumers, or 13.9 per cent. in three years. There was an increase of 4,687 electric water heaters, or 120.4 per cent. over the number installed in 1924, and of these Hydro Shops sold 1,503, or

TABLE No. 3.

DATA ON WATER HEATERS IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Water Heaters			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton.......	399	455	56	10	19	9	9
Border Cities.	17,458	22,509	5,051	1,950	4,606	2,982	460
Belleville.....	2,800	2,779	−21	55	223	168	88
Bowmanville	850	929	79	130	162	32	28
Chatham.....	3,517	3,727	210	150	190	40	24
Cobourg.....	1,000	1,025	25	12	15	3	2
Exeter.......	358	421	63	30	46	16	16
Forest.......	400	439	39	6	27	21	21
Guelph.......	4,332	4,634	302	118	186	68	4
Kitchener....	4,895	5,813	918	57	297	240	16
London......	14,957	16,065	1,108	400	1,125	725	422
Midland.....	1,385	1,541	156	115	191	76	26
Mitchell.....	393	427	34	9	12	3	7
Napanee.....	650	715	65	30	90	60	38
North Bay...	2,506	2,881	381	75	190	115	20
Owen Sound..	2,548	2,846	298	68	118	50	15
Petrolia......	581	631	50	16	30	14	15
Picton.......	816	911	95	34	90	56	44
St. Marys....	904	981	77	40	70	30	22
Stamford.....	869	1,193	324	45	78	33	126
Stratford.....	4,036	4,174	138	300	415	115	52
Strathroy....	681	731	50	27	47	20	19
Trenton......	1,100	1,117	17	20	39	19	8
Woodstock...	2,409	2,603	194	196	314	118	21
Totals...	69,838	79,547	9,709	3,893	8,580	4,687	1,503
			Increase 3 years 13.9%		Saturat'n 10.8%	Increase 120.4%	Sales 32.1% of 3 years Increase

TABLE No. 4.

DATA ON ELECTRIC WASHERS IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Washers			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton.......	399	455	56	34	66	32	32
Border Cities.	17,458	22,509	5,051	5,800	9,719	5,028	1,530
Belleville.....	2,800	2,779	−21	300	508	208	155
Bowmanville	850	929	79	225	285	60	32
Cobourg.....	1,000	1,025	25	300	341	41	22
Exeter.......	358	421	63	45	70	25	17
Forest.......	400	439	39	61	88	27	19
Goderich.....	1,181	1,061	−120	150	233	83	4
London......	14,957	16,065	1,108	3,000	5,150	2,150	657
Midland.....	1,385	1,541	156	392	647	255	113
Napanee.....	650	715	65	45	176	131	26
North Bay...	2,506	2,881	381	150	375	225	9
Owen Sound..	2,548	2,846	298	177	409	232	9
Petrolia......	581	631	50	37	121	84	62
Picton.......	816	911	95	25	45	20	8
St. Marys....	904	981	77	88	132	44	27
Stamford.....	869	1,193	324	57	705	648	316
Stratford.....	4,036	4,174	138	800	1,275	475	218
Strathroy....	681	731	50	85	123	38	35
Trenton......	1,100	1,117	17	90	168	78	42
Wallaceburg .	785	910	125	110	410	300	70
Woodstock...	2,409	2,603	194	268	335	67	17
Totals...	58,673	66,917	8,244	12,239	21,381	9,142	3,420
			Increase in 3 yrs. 14.1%		Saturat'n 32.0%	Increase 3 years 74.7%	Sales 37.4% of 3 yrs. Increase

32.1 per cent. of the total installations. It would seem as though the public were very poorly informed as to the advantages of heating water electrically. To those who have used an electric water heater properly installed this service is one of the greatest conveniences in the modern

home, but I believe that too little effort is being exerted to sell electric water heaters, and this may be for the reason that very little information is available for the use of sales folks to properly inform prospective customers on the cost of installation, the measure of service which may be obtained, and the cost of operation, and because it requires certain en-

TABLE No. 5.

DATA ON VACUUM CLEANERS IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Vacuum Cleaners			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton	399	455	56	13	23	10	12
Border Cities	17,458	22,509	5,051	8,000	9,877	3,534	532
Belleville	2,800	2,779	−21	400	529	129	99
Chatham	3,517	3,727	210	300	450	150	6
Cobourg	1,000	1,025	25	200	240	40	32
Exeter	358	421	63	35	38	3	1
Forest	400	439	39	50	88	38	6
Goderich	1,181	1,061	−120	75	233	158	2
London	14,957	16,065	1,108	3,000	4,675	1,675	390
Midland	1,385	1,541	156	178	215	37	17
Mitchell	393	427	34	75	200	125	14
Napanee	650	715	65	70	74	4	14
North Bay	2,506	2,881	381	100	350	250	69
Owen Sound	2,548	2,846	298	92	190	98	3
Picton	816	911	95	76	90	14	3
St. Marys	904	981	77	63	85	22	9
Stratford	4,036	4,174	138	400	590	190	63
Strathroy	681	731	50	68	94	26	25
Trenton	1,100	1,117	17	80	89	9	6
Wallaceburg	785	910	125	101	225	124	20
Woodstock	2,409	2,603	194	477	513	36	10
Totals	60,283	68,318	8,035	13,853	18,868	5,015	1,333
			Increase in 3 years 13.3%		Saturat'n 27.9%	Increase 3 years 36.2%	Sales 26.5% of 3 yrs. Increase

TABLE No. 6.

DATA ON IRONERS IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Ironers			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Border Cities.	17,458	22,509	5,051	100	247	147	70
Belleville.....	2,800	2,779	−21	....	10	10	3
Bowmanville	850	929	79	4	6	2	2
Chatham.....	3,517	3,727	210	10	14	4	....
Cobourg.....	1,000	1,025	25	....	5	5	2
Exeter.......	358	421	63	....	1	1	1
Forest.......	400	439	39	1	4	3	3
Goderich.....	1,181	1,061	−120	2	7	5	....
Guelph......	4,332	4,634	302	3	7	4	....
London......	14,957	16,065	1,108	100	170	70	30
Lindsay......	1,800	1,769	69	....	5	5	....
Midland.....	1,385	1,541	156	11	24	13	5
Mitchell.....	393	427	34	2	2	....	1
New Hamburg	291	320	29	....	1	1	....
Napanee.....	650	715	65	....	1	1	1
North Bay...	2,506	2,881	381	1	4	3	....
St. Marys....	904	981	77	3	6	3	....
Stamford.....	869	1,193	324	....	4	4	6
Stratford.....	4,036	4,174	138	5	10	5	1
Tillsonburg...	667	764	97	3	4	1	1
Woodstock...	2,409	2,603	194	8	14	6	4
Totals...	62,763	70,957	8,294	253	546	293	130
			Increase in 3 yrs. 13.4%		Saturat'n 0.7%	Increase 116.0% 3 years	Sales 45.5% of 3 yrs. Increase

gineering knowledge to give a customer correct information rather than go to the trouble of getting the necessary information the electric water-heater is side-tracked to the disadvantage of the local utility and the customer alike.

Table No. 4 dealing with *Electric Washing Machines* gives information on 22 Hydro Shop municipalities

involving an increase in domestic customers of 8,244, or 14.1 per cent. in three years, an increase in the number of washing machines reported in use of 9,142, or 74.7 per cent. in three years, of which 3,420 were sold by Hydro Shops, being 37.4 per cent. of the increased use. In the case of washers the number installed is considerably greater than the number of new customers added, and one cannot help but think that this increase is due entirely to the fact that washing machine manufacturers perhaps more than all others have been able to break down sales resistance by continuous effort. I believe there is more intensive campaigning on washing machines with the possible exception of vacuum cleaners and refrigerators, than there is on any other electrical commodity, and when

TABLE No. 7.

DATA ON REFRIGERATORS IN HYDRO SHOP TOWNS

Municipality	Domestic Consumers			Number of Refrigerators			
	Number Served end of 1924	Number Served end of 1927	Number Added in 3 years	In Use Dec. 31, 1924	In Use Dec. 31, 1927	Increase in 3 years	Sold by Hydro Shop
Acton........	399	455	56	....	1	1	....
Border Cities.	17,458	22,509	5,051	63	800	737	227
Belleville.....	2,800	2,779	−21	....	6	6	4
Bowmanville	850	929	79	....	11	11	6
Chatham.....	3,517	3,727	210	3	30	27	8
Exeter.......	358	421	63	....	10	10	....
Forest.......	400	439	39	....	3	3	2
London......	14,957	16,065	1,108	25	375	350	67
Midland.....	1,385	1,541	156	....	33	33	8
Mitchell	393	427	34	....	1	1	1
St. Marys....	904	981	77	1	11	10	6
Stamford.....	869	1,193	324	....	8	8	1
Stratford.....	4,036	4,174	138	....	7	7	3
Wallaceburg..	785	910	125	1	15	14	11
Woodstock...	2,409	2,603	194	1	12	11	7
Totals...	51,520	5,953	7,633	94	1,323	1,299	351
			Increase in 3 yrs. 14.8 %		Saturat'n 2.0 %	Increase 3 years 1386.0%	Sales 26.7 % of 3 yrs. Increase

you consider that a washing machine is used only a few hours a week as compared with many hours of the electric range and the electric water heater, and other commodities, it is hard to understand why the public are not more anxious to purchase these other appliances which would give them more comfort and convenience.

Table No. 5 gives the details for 21 Hydro Shop municipalities involving an increase of 8,035 domestic consumers, or 13.3 per cent. in three years, an increase of 5,015 vacuum cleaners, or 36.2 per cent. in three years, of which 1,333 were sold by the Hydro Shops in these municipalities, 26.5 per cent. of the total number sold.

Table No. 6, on *Electric Ironers*, shows what is going on in 22 Hydro Shop municipalities, involving an increase of 8,294 customers, or 13.4 per cent. in three years, 293 ironing machines, or 116 per cent. in three years, of which the Hydro Shops in these municipalities sold 130, being 45.5 per cent. of the total installed.

Table No. 7 gives information on 15 Hydro Shop municipalities involving an increase of 7,633 in the number of domestic customers, or 13.9 per cent., and 1,299 in the number of electric refrigerators installed, or 1386 per cent., of which Hydro Shops in these municipalities sold 351, representing 26.7 per cent. of the total number installed. Here is an example of what intensive selling will do. The figure 1289 by no means represents the total number of electric refrigerators installed during the three year period, as you will notice that the city of Toronto, the city of Hamilton and Ottawa are not included in this list, for the reason that no figures were available to show the total number installed in 1924. Here again the convenience of an electric refrigerator cannot reasonably be considered as exceeding that of the electric range or the electric water heater, and most electric refrigerators cost two or three times as much as a range to install, yet the public are being sold on electric refrigeration. The comparatively few sales made by Hydro Shops indicate again that on account of the engineering knowledge required to properly sell and install an electric refrigerator most Hydro Shops have left in the hands of the manufacturers the job of disposing of these appliances.

A lot more could be said about the information contained in these tables, but time will not permit of too long a discourse at the present time. Since, however, these tables are before you in print, you can study them yourselves, and draw your own conclusions.

In order to show the results of other selling agencies than Hydro Shops, a number of municipalities in which no Hydro Shop is being operated, were selected, for which data on the increase in the number of domestic consumers, and the increase in the number of appliances in use are presented for study and comparison.

Table No. 8 lists 22 *Non-Hydro Shop Municipalities* involving an increase of 2,960 consumers, 12.1 per cent., and 1,967 electric ranges, or 42.5 per cent. increase in the three year period. In selecting these muni-

TABLE No. 8.

DATA ON RANGES IN NON-HYDRO SHOP TOWNS.

Municipality	Domestic Consumers			No. of Ranges in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1914	Dec. 31, 1927	Increase
Alliston	301	323	22	12	28	16
Brampton	1,148	1,259	111	50	250	200
Brantford	5,337	5,957	620	1,517	2,040	523
Dutton	182	196	14	6	8	2
Durham	297	341	44	8	9	1
Hespeler	611	619	8	56	71	15
Hanover	601	626	25	100	116	16
Mimico	1,308	1,464	156	400	530	130
Mount Forest	310	367	57	16	27	11
Merritton	590	600	10	60	100	40
Milverton	190	203	13	14	35	21
Orillia	2,000	2,310	310	220	395	175
Port Credit	302	336	34	62	118	56
Preston	1,295	1,440	145	370	487	117
Prescott	502	574	72	34	98	64
Port Dalhousie	523	548	25	30	68	38
Scarboro	2,529	3,128	599	250	333	83
Stayner	204	210	6	6	13	7
St. Catharines	4,851	5,371	520	1,024	1,384	360
Tavistock	203	239	36	40	67	27
Waterford	269	299	30	25	40	15
Weston	951	1,054	103	325	375	50
Totals	24,504	27,464	2,960 Increase 12.1%	4,625	6,592 Saturation 24.0%	1,967 Increase 42.5%

cipalities an effort was made to choose those which would compare in size with the majority of those on the list of Hydro Shop towns, so that any comparisons which are drawn will be fairly representative.

Table No. 9 on *Hotplates* shows what happened in 15 municipalities, involving an increase of 1,401 consumers, or 10.1 per cent., and 792 hotplates, or 118 per cent.

Table No. 10 on *Electric Washers* shows what took place in 18 municipalities, involving an increase of

TABLE No. 9.

DATA ON HOT PLATES IN NON-HYDRO SHOP TOWNS

Municipality	Domestic Consumers			No. of Hot Plates in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	18	30	12
Brampton	1,148	1,259	111	25	200	175
Brantford	5,337	5,957	620	300	415	115
Dutton	182	196	14	5	5	..
Durham	297	341	44	3	15	12
Hespeler	611	619	8	22	74	52
Hanover	601	626	25	23	50	27
Mount Forest	310	367	57	24	35	11
Merritton	590	600	10	25	100	75
Milverton	190	203	13	2	3	1
Orillia	2,000	2,310	310	100	350	250
Port Credit	302	336	34	2	27	25
Prescott	502	574	72	100	175	75
Port Dalhousie	523	548	25	3	35	32
Tavistock	203	239	36	20	30	10
Totals	13,097	14,498	1,401	672	1,464	792
			Increase 10.1%		Saturation 10%	Increase 118.0%

2,154 consumers, or 12.7 per cent., and an increase of 2,181 washers, or 119.3 per cent. in three years. In these municipalities it will be seen that the number of washers installed in three years exceeds the increase in the number of consumers added to the lines. This compares favourably with the data on Table No. 3 in Hydro Shop Towns.

Table No. 11 gives information on 13 municipalities involving an increase of 1,374 consumers, or 11.1 per cent., 621 vacuum cleaners, or 57.3 per cent. in three years.

Table No. 12 gives information on 13 municipalities, involving an increase of 1,893 consumers, or 10.6 per cent., and 605 water heaters, or 68.5 per cent. It would appear that Hydro Shops are doing a better job on water heaters than private dealers, as one would expect.

Table No. 13 on *Electric Ironers* shows that in 13 municipalities there was an increase of 887 consumers, or

TABLE No. 10

DATA ON WASHERS IN NON-HYDRO SHOP TOWNS

Municipality	Domestic Consumers			No. of Washers in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	75	120	45
Brantford	5,337	5,957	620	350	1,700	1,350
Dutton	182	196	14	60	70	10
Durham	297	341	44	45	56	10
Hespeler	611	619	8	175	179	4
Hanover	601	626	25	50	86	36
Mimico	1,308	1,464	156	150	310	160
Mount Forest	310	367	57	20	50	30
Merritton	590	600	10	20	50	30
Milverton	190	203	13	45	50	5
Orillia	2,000	2,310	310	200	225	25
Port Credit	302	336	34	10	35	25
Prescott	502	574	72	15	40	25
Port Dalhousie	523	548	25	15	40	25
Scarboro	2,529	3,128	599	360	424	64
Stayner	204	210	6	12	28	16
Tavistock	203	239	36	25	45	20
Weston	951	1,054	103	200	500	300
Totals	16,941	19,094	2,154	1,877	4,008	2,181
			Increase 12.7 %		Saturation 20.9 %	Increase 119.3 %

12.5 per cent., and 17 ironing machines, or 55 per cent. in three years.

Table No. 14, involving 23 municipalities, shows an increase of 2,575 consumers, or 12.5 per cent., and 119 electric refrigerators, or 744 per cent. in three years.

In submitting these two sets of tables for Hydro Shop towns and Non-Hydro Shop towns, no attempt is made to compare the sales efforts by Hydro Shops with those of private dealers. In order to make such a comparison the results of all Hydro Shop towns should be compared with the results of all Non-Hydro Shop towns, but I believe that the statistics contained in these 14 tables will be

interesting to the municipalities involved, and to the manufacturers of electrical appliances as well.

As in previous years the statistics in connection with the number of electrical appliances installed in all the Hydro municipalities in the Province have been compiled and are compared with the results obtained in 1924.

Table No. 15 shows the total number of 12 major appliances estimated in use at the end of 1924, the percentage saturation reached at that time and the estimated installed capacity in kilowatts, the same information at the end of 1927 and shows the increase in the number of appliances in use in the three years with its effect on the saturation and installed capacity, and in the last column the total sales by all the Hydro Shops in the Province are indicated. The figures in this table contain some very interesting information which will bear close study by all who are interested in this subject. It will be noticed that in some cases there is a decrease in the number of appliances reported in use at the end of 1924 and the end of

TABLE No. 11.

DATA ON VACUUM CLEANERS IN NON-HYDRO SHOP TOWNS.

Municipality	Domestic Consumers			No. of Vac. Cleaners in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	6	40	34
Brampton	1,148	1,259	111	75	300	225
Brantford	5,337	5,957	620	600	800	200
Dutton	182	196	14	35	40	5
Durham	297	341	44	50	54	4
Hanover	601	626	25	36	50	14
Mount Forest	310	367	57	21	30	9
Merritton	590	600	10	50	100	50
Orillia	2,000	2,310	310	150	150	..
Port Credit	302	336	34	25	50	25
Prescott	502	574	72	25	40	15
Port Dalhousie	523	548	25	20	60	40
Waterford	269	299	30	40	40	..
Totals	12,362	13,736	1,374	1,083	1,704	621
			Increase 11.1 %		Saturation 12.4 %	Increase 57.3 %

TABLE No. 12.

DATA ON WATER HEATERS IN NON-HYDRO SHOP TOWNS

Municipality	Domestic Consumers			No. of Water Heaters in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	4	12	8
Brampton	1,148	1,259	111	25	125	100
Brantford	5,337	5,957	620	200	350	150
Dutton	182	196	14	5	5	..
Durham	297	341	44	2	3	1
Hespeler	611	619	8	16	19	3
Hanover	601	626	25	24	40	16
Mount Forest	310	367	57	6	10	4
Merritton	590	600	10	20	30	10
Milverton	190	203	13	6	9	3
Orillia	2,000	2,310	310	100	160	60
Prescott	502	574	72	25	65	40
Port Dalhousie	523	548	25	11	36	25
Stayner	204	210	6	2	5	3
St. Catharines	4,851	5,371	520	428	606	178
Tavistock	203	239	36	9	13	4
Totals	17,850	19,743	1,893	883	1,488	605
			Increase 10.6 %		Saturation 7.5 %	Increase 68.5 %

1927. This obtains in the case of grates and grills and may be explained by the fact that municipalities have not been as particular giving information as to the number of these appliances in use as they have on other appliances, and it is impossible to check the figures of 1924. It is felt, however, that the figures shown for 1927 are as nearly accurate as it is possible to make them. One interesting feature of this table No. 15 lies in the fact that the estimated installed capacity of these 12 appliances has increased 350,321 kilowatts, or over 467,000 h.p., and while it is impossible to calculate the exact effect of this increase on the demand for power, nevertheless, it must be realized that if ever the public wake up, as they will some day, to the advantages of home electrification, the

question of power supply will be one for serious consideration.

I have a little information on the use of electrical appliances among the farmers of Ontario which might be of interest.

In a recent survey conducted by a well known Research Bureau in the city, questions were asked regarding the use of electricity on the farm, particularly in the farm home, and the following information was gathered from the questionnaires sent out :

Out of 781 forms returned, 691 farmers replied to the question, "Is your farm connected with an electric power line ?" Of the 691, 99 or 14 per cent. replied in the affirmative and 592, or 86 per cent. replied in the negative. Of the 99 who had electric service the following were the appliances in use :

86, or 87 per cent, owned an electric iron.

TABLE No. 13.

DATA OF IRONERS IN NON-HYDRO SHOP TOWNS

Municipality	Domestic Consumers			No. of Ironers in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	3	3	..
Brampton	1,148	1,259	111	2	10	8
Durham	297	341	44	1	2	1
Hespeler	611	619	8	2	3	1
Hanover	601	626	25	3	3	..
Mimico	1,308	1,454	156	6	12	6
Mount Forest	310	367	57	1	1	..
Merritton	590	600	10	1	1	..
Orillia	2,000	2,310	310	4	4	..
Prescott	502	574	72	4	5	1
Stayner	204	210	6	1	1	..
Tavistock	203	239	36	1	1	..
Waterford	269	299	30	2	2	..
Totals	8,344	9,231	887	31	48	17
			Increase 10.5 %		Saturation 0.5 %	Increase 55.0%

TABLE No. 14.

DATA ON REFRIGERATORS IN NON-HYDRO SHOP TOWNS

Municipality	Domestic Consumers			No. of Refrigerators in Use		
	Number Served Dec. 31, 1924	Number Served Dec. 31, 1927	Increase	Dec. 31, 1924	Dec. 31, 1927	Increase
Alliston	301	323	22	..	16	16
Brampton	1,148	1,259	111	..	10	10
Brantford	5,337	5,957	620	..	25	25
Dutton	182	196	14	..	1	1
Durham	297	341	44	..	2	2
Hespeler	611	619	8	1	4	3
Hanover	601	626	25	..	6	6
Mimico	1,308	1,464	156	10	20	10
Meaford	493	571	78	..	6	6
Mount Forest	310	367	57	..	3	3
Merritton	590	600	10	..	1	1
Milverton	190	203	13	..	3	3
New Toronto	886	962	76	..	1	1
Orillia	2,000	2,310	310	2	4	2
Port Credit	302	336	34	..	6	6
Preston	1,295	1,440	145	2	6	4
Port Perry	217	263	46	..	4	4
Prescott	502	574	72	..	3	3
Port Dalhousie	523	548	25	..	5	5
Scarboro	2,529	3,128	599	..	1	1
Stayner	204	210	6	..	4	4
Waterford	269	299	30	1	7	6
Whitby	660	734	74	..	7	7
Totals	20,755	23,330	2,575	16	135	119
			Increase 12.5%		Saturation .6%	Increase 744.0%

50, or 51 per cent. owned an electric toaster.

41, or 42 per cent. owned an electric washer.

19, or 20 per cent. owned an electric range.

15, or 15 per cent. owned a vacuum cleaner.

11, or 11 per cent. owned an electric grill, and

2, or 2 per cent. owned an electric fan.

TABLE NO. 15

	Number estimated in use in Ontario Dec. 31, 1924	Per-centage Saturation	Estimated installed capacity kw.	Number estimated in use Dec. 31, 1927	Per-centage Saturation	Estimated installed capacity kw.	Increase in number in use in 3 years	Per-cent Increase	Increase in Saturation	Increase in installed capacity in 3 yrs. kw.	Number sold by Hydro Shops in 3 yrs.
Ranges......	47,505	13.8	285,030	83,298	21.3	499,788	35,793	75.3	7.5%	214,758	12,533
Hot Plates...	18,883	5.5	37,766	34,178	8.9	68,356	15,295	81.0	3.4%	30,590	3,057
Washers.....	55,342	15.8	11,068	92,219	23.5	18,443	36,877	66.7	7.7%	7,375	6,524
Vac. Cleaners	64,205	18.6	12,841	88,539	22.5	17,707	24,334	37.9	3.9%	4,861	4,259
Water Heaters	16,665	4.8	25,000	32,211	8.2	48,316	15,546	93.3	3.4%	23,316	2,814
Grates.......	15,075	4.4	30,150	13,309	3.4	26,618	−1,766	......	......	−3,532	544
Air Heaters...	130,000	30.0	82,400	131,531	33.4	105,225	28,531	27.7	3.4%	21,825	3,242
Ironers.......	1,590	.4	4,770	2,403	.6	7,209	813	51.1	.2%	2,439	277
Irons........	307,800	89.2	203,148	363,476	92.8	239,894	55,676	18.0	3.6%	36,746	23,096
Refrigerators.	657	.2	130	11,176	2.9	2,235	10,519	1,600.0	2.7%	2,005	578
Toasters.....	152,200	44.1	83,710	171,317	44.2	94,224	19,117	12.6	.1	8,514	7,484
Grills........	46,800	13.8	30,888	44,254	11.3	29,207	−2,546	......	......	−1,681	2,203
			806,901 kw.			1,157,222 kw.				350,321 kw.	

Comparing these percentages with those of the total number of appliances in use in urban centres, we find that the irons, toasters, ranges and grills are about the same. The washing machines are more plentiful in rural communities. Sweepers are not so numerous.

In studying closely the results as shown by the various tables, one cannot but be impressed with the fact that the progress towards saturation in the electrical appliance field in Ontario is exceedingly slow. Those of you who read magazines from across the Border will know that the same situation confronts the electrical industry in the United States as it does here. That is, there is a lack of intensive effort on the part of those who perhaps could do most to advance the cause of the use of electrical appliances, and the reasons for the poor showing which the industry is making are eagerly sought after, so that a remedy could be applied to stir things up. A brief review of the situation here leads us to believe that there are three outstanding reasons for the poor showing made in Ontario. These may be enumerated as follows :

1st. While the electrical dealers, the hardware men, Hydro Shops, and others engaged in selling electrical appliances are quarreling with one another as to which has the best right to sell electrical merchandise, the musical instrument dealers, gas companies, radio dealers, furniture and automobile salesmen, are laying hold of the prospects who have money to spend and are tying them down with obligations which prevent them entertaining any thought of the purchase of electrical appliances, much though they need them. It would seem that the remedy for this situation would be a campaign of national advertising conducted with the co-operation of all interests for the benefit of everybody.

2nd. The lack of proper education among those in the electrical industry who are actively engaged in the selling of electrical appliances of the advantages, conveniences and economies of electrical appliances. How many sales folks have actually experienced the inconvenience, discomfort and lack of cleanliness by cooking with any other than an electric range, and then experiencing the thrill of using an electric range for the first time. Personally, I have had this experience and I know the effect my experience has had on any prospective range customers with whom I may come in contact. How many sales folks have experienced the inconvenience and drudgery of doing a large family washing by hand and then doing a real big washing in a real good electric washer. I have, and I know the effect of my experience on any prospects I may come in contact with. If sales folks had this experience and thought for one minute that 79 per cent. of the women of Ontario were still cooking by antiquated methods, and that 77 per cent. of the women of Ontario are still bending over the tub and wringing the clothes out by hand they would work 24 hours per day to try and relieve this drudgery alone, without giving a thought to the making of money in the selling of appliances to these people. How

many of those engaged in the selling of appliances know what it is to have an efficient system of electric water heating. I am sure that if a salesman has a water heater operated electrically in his own home, one that is giving perfect satisfaction and is costing little to operate, it would not take him long to convert a great many prospects to the advantages and the economies of heating water by electricity. In talking to salesmen I find that there is a general lack of authentic information on heating water by electricity. How many sales folks are thoroughly familiar with the cost of operating the appliances they are trying to sell. Contrast the above conditions with those of radio salesmen or automobile salesmen. These know all about all kinds of the equipment, including those which they are trying to sell, and it is through this knowledge that they are able to give to prospective customers the information which they desire and that which makes sales.

3rd. The third reason for the poor showing is the failure of electrical appliance manufacturers to realize that in order to live an electrical dealer must get a fair income from his business to place him in the same position as other merchants in the municipality in which he lives. It is a well known fact that the cost of selling, installing and servicing electrical appliances is greater than that of any other well known commodity, and the worries of the electrical dealer seem to commence with sales, whereas those of dealers in a great many other commodities end at that point. The electrical dealer must use up the greater part of his profit to keep his customers satisfied, and to retain the confidence of electrical customers in the appliances which the manufacturer turns out.

Discussion

Mr. V. B. Coleman, Port Hope: One reason why people do not push certain electrical appliances more than they do a washing machine that is only used for a short time is that the washing machine is one appliance that any woman in any house, who has to do the washing herself, sets her heart on getting; The paper is summed up, I think, in the reason why electrical things are not put, is because of the servicing of the various appliances being a very expensive proposition indeed. The hardware merchants in our town used to sell electrical appliances, but they were very glad to turn it over to the Hydro shops. They are now, however, beginning to learn the use of electrical appliances and how to take care of them. Every salesman should learn how to service electrical appliances. At first, the merchants who sold them thought the Hydro shops were taking part of their profit, but now they are beginning to learn how to service the appliances as well as the Hydro shops.

Mr. Mickler: I think that bears out the statement I made in the last reason; that the men who are selling electrical appliances need more in the

way of margin to take care of the cost of servicing.

Mr. F. Newman, Picton: I would like to ask, what percentage of profit if it has been figured out, should a Hydro shop have on general appliances such as washing machines and so forth.

Mr. Mickler: It has not been figured out for 1927. We know, the margin that is given is not sufficient to render any spectacular profit, and, at that, a great deal of the servicing which should be done is left undone, and a great many appliances which should be used are lying on the shelves because there is something wrong with them and nobody will take the time or spend the money or worry about the servicing of them. I do not know what margin a person should have to cover all those things, but I feel sure if a little more margin were given the contractor-dealer and the Hydro shops, they would be able to go after and try to fix up those appliance that are not giving 100 per cent. service.

Dr. W. R. Carr: Have any steps been taken to approach the manufacturers to get Hydro dealers and other merchandisers together and to get this percentage increased?

Mr. Mickler: Not that I know of, Dr. Carr. The matter has been discussed many times, but the question as to who is the one to initiate the movement of that kind is what has kept it back. I read magazines from across the line once in awhile, and I know the margin they get there is greater than it is here. But they don't make any money either.

Mr. J. J. Heeg, Guelph: The biggest thing I see about the handling of the high-priced electric ranges particularly is that the manufacturers change the design so often. You get a stock of ranges and shortly afterwards the design is changed. With the small profit we have on electric ranges, they would have to be sold at a loss. The other appliances are not changed in design so often and the situation is not so bad.

Mr. Mickler: I think that is where the publicity comes in. If a Hydro shop has a stock of electrical appliances that are apt to be changed in design, they ought to try to sell them by continuous and intensive effort, instead of keeping them in stock. In other words, keep that stock revolving without incurring any loss. It is a question of advertising, purely.

Mr. E. E. Bowley, Simcoe: I would like to ask Mr. Mickler what he thinks the effect of the proposed increased service charge for domestic users will be on appliance sales? I understand that a change is to be made shortly from thirty cents net to sixty cents. Do you think that will have much effect on appliance sales, once it is generally known?

Mr. Mickler: I do not imagine, that a slight increase in the service charge should have very much effect if proper sales efforts were put across. People do not worry much about the three-cent tax on gasoline if they want to drive a motor car, or about the increase in cost of loudspeakers, if they want to buy a radio. It is a question of selling, purely and simply. Across the line, they pay six and seven

cents per kw-hr., and pay a service charge of so much per element on a stove, and they are selling a lot of ranges in a great many communities. I think, up to the present time, people have been buying. They have not been sold. But now we have got to get out and sell. The buying has stopped.

Mr. Coleman: The increased rate is not going to make it a harder proposition for a man to sell an appliance. As far as the customer is concerned, if he wants a thing, he is going to buy it.

Mr. Newman: I think Mr. Mickler might give us a little more satisfaction on the question I asked before. We have no problems in Picton—everything is going smoothly. The Hydro store is supposed to give service at cost. It would be generally to the satisfaction of the delegates here if Mr. Mickler would instruct us as to the amount of profit we should have in the sale of washers, irons and other electrical appliances in order to give the salesmanship service in following up that the office is supposed to give. We are all depending on the office to take the lead and recommend what should be sold; and it is not fair to expect an office to be selling at too close a margin and losing money or charging too much. The profits are not sufficient to pay the expenses. If they are neglecting the salesmanship, it is because the office is supposed to give the service on which Hydro has been built up. The foundation is "Service at Cost." We are entitled to the service; and the intimation in his address was that there was probably some neglect in the salesmanship, possibly because the profits of the office were not sufficient to give the people the service they desire.

Mr. Mickler: Without definite knowledge or information as to the results of operation of Hydro stores for 1927, I cannot tell just what effect the present method of operation has had in general or in particular. With particular reference to Picton, I understood, and I think, their Hydro shop is operating on a very sound basis. At the same time, there are certain local conditions in Picton which, perhaps, are not general throughout the Province. We know that, in a great many Municipalities, they require, on account of the amount of business that is done and to be done, several staffs to do it, and who are really up-to-date and aggressive. One Hydro shop doing a considerable business is maintained on the same basis as would be any ordinary respectably sized contractor-dealer business. Some years ago—I think it was in 1923 or 1924—I addressed this gathering on the policy which should govern the operation of a Hydro shop. One of the principles set out in that policy was, first, that Hydro shops should conduct their business on a business basis, that they should compete with their competitors fairly, and one of the first principles of fair competition is the maintenance of re-sale prices where such are established.

Now the question of service at cost, so far as the sale of electrical merchandise in Hydro shops is concerned, cannot be rigidly adhered to. What we might do, though, instead

of giving service at cost—if we make a little profit—is to turn that profit to the consumers' benefit by additional service, and I think that is where some are, perhaps, falling down. In that same address, I outlined the system of accounting which each Hydro shop could instal to be able to show definitely what it costs to operate, and I am sure that, in some cases, they are not charging all that should be charged to Hydro shop operation. On the other hand, in some cases, more is being charged than is the legitimate expense of Hydro shop operation. But I know that, if all the charges that can be legitimately charged against merchandising in Hydro municipalities, are charged against the margin that is made when goods are sold, there is very little left to do servicing. To wait for people to bring things in is not the proper attitude; I think they ought to go out and look for servicing. People are not anxious to incur a bill of expense. If they do not know that service is being given free, or at a minimum expense, they would sooner let their washing machine or iron go into disuse rather than go to any expense in getting it fixed up.

As to what should be a fair margin, I cannot tell until we have definite figures before us. At the end of 1926, the partial results of thirty Hydro municipalities showed a net profit of 2.3 per cent. of the sales. The cash discount is all that they made. That is not enough. Now, I consider a great many Hydro municipalities are in a very favourable position as compared with their competitors. The Hydro municipalities are not obliged to be in the merchandising business. Hydro is operated by a Commission. The Commission employs a Manager. The Manager's salary goes on whether there is a Hydro shop or not, and whether it is doing a lot of business or a little business, his salary is the same. The contractor-dealer is in the contractor-dealer business. He is a competitor, depending entirely on the business he does, in competition with the Hydro shop, for a living. All the expense of his staff has to be set against the margin he makes; and I am speaking, not for Hydro shops in particular, but for the entire electrical industry, when I say the servicing is not being done that could be done, because they do not get enough money for it. If they got a little bit more, I am sure the Hydro shops, as well as the contractor-dealers, would try to keep things in a little better service than they do now, and perhaps would sell a lot more stuff, because with others than our own Institutions the profit that they make on sales is the thing that governs their efforts. If they could make a little more, I am sure we would find a lot more ranges and washing machines installed instead of finding such a tremendous increase in the number of automobiles and other things in use. Something is wrong, because there is a lot more labour in trying to make a fire on a winter morning with a lot of wet wood than trying to start a car. But they will have the car, and won't try and get some easier way of providing a meal in the morning.

A Proposal for Improved Primary Distribution

by J. G. Jackson, Manager, Public Utilities Commission, Chatham

(Read before Association of Municipal Electrical Utilities at Niagara Falls on June 15, 1928.)

THE writer is of the opinion that a very substantial improvement in operating conditions can be obtained in the majority of systems with increased safety to linemen and to the public, and with less interruptions to service during storms and sleet conditions, and that this plan may be carried out at a moderate cost with improvement in regulation and a reduction in copper losses, which, taken together with reduced maintenance costs, will fully justify the investment required to carry out the plan.

This distribution method could be applied in laying out a new system, but the writer has considered the matter mainly from the standpoint of the revision of an existing distribution system of conventional design which may be considered to have been in service ten or more years, and requiring some attention due to pole depreciation and the necessity for increased conductor sizes as a result of load conditions attained during the period of service.

This plan is, in general, to place all primary feeders in lead covered cables of such size as to considerably exceed the current carrying capacity required for the individual feeders, to sectionalize feeders, preferably at transformer locations, and to arrange adjacent feeders so that through sectionalizing points, each pair of two feeders will form a loop back to the same station bus, the sectionalizing connections being open nominally at the point dividing the two feeders thus linked up. Obviously this loop system could also be carried out, using a group of three feeders with alternative connection to one or other of two.

The type of construction proposed includes the use of lead covered 3-conductor cables for main feeders in standard conduit systems in locations where the number of cables required would justify this, and similar cables in wrought iron pipe or armoured and covered with a protective plank in locations where one or two cables, only, are required. These main feeders would be chosen with conductor sizes as large as practicable, and in the case where original overhead conductors of No. 4 and No. 2 sizes are being replaced, a logical replacement size would appear to be 250 M cir. mils. It is to be remembered that an error on the side of excessive conductor area will more readily justify itself than the use of undersize conductors.

Feeder branch cables, extending from the main feeder to individual transformers or groups of several transformers, and not forming part of the principal loop system, will vary in size with the requirements of the load expected in the area fed, but will conform to main feeder sizes where expected future extensions may render this desirable. These branch feeders may be single or three conductor for a star connected system, or two or three conductor for a delta connected system. The three and two conductor cable may be installed in wrought iron pipe or armoured, while the single conductor it is considered, should preferably be installed armoured with plank protection. It is thought best to choose a single size of conductor suitable to present and future load conditions for branch cables and use this throughout with few exceptions.

In the ordinary case No. 2 will be found to be a very useful size for this purpose. To reach transformer locations not permanently defined, lead covered cable in the smaller sizes carried on messengers over existing pole lines, as in standard telephone construction, would appear to be permissible.

At sectionalizing points, chosen with respect to load included and convenient transformer locations and intersections of streets carrying branch cables, the cable ends of adjacent sections are to be brought up poles or transformer structures using disconnecting type potheads, preferably with a convenient locking feature. These potheads should be mounted on opposite sides of a double cross arm with a flexible varnished cambric, weatherproof-covered jumper connecting between, mounted on an insulator such that sufficient flexibility without too great freedom of movement may be had. A dummy cap over disconnected pothead terminals will prevent accidental contacts. Single or multiple conductor taps will be taken off these connecting links, and it is considered desirable that such connections be made through a suitable fusible disconnecting switch or cutout. The writer is of the opinion that with the improved forms of line cutouts now available, in sizes up to 100 amperes, it is desirable to fuse primary branches, although this is not essential.

As an alternative to the bringing up of main cable ends at sectionalizing points, an underground type of three way junction box may be employed. This, however, would require a manhole and except at an existing manhole location, would increase the cost of the sectionalizing equipment very greatly. On the other hand, an added length of feeder of 5 to 10 per cent. results from bringing the cable ends up to potheads, with corresponding difference in losses. As this distribution method lends itself readily to the use of the type of transformer recently developed for mounting with the tank directly in the soil, it is possible that new transformers of this type, would in some cases be installed, and in case this were done at sectionalizing points, an added reason would thus be provided for the use of underground junction boxes for sectionalizing in such cases. It would appear, however, that the overhead connection by means of potheads with short weather-proofed,

insulated jumpers will be the most generally useful sectionalizing method.

The loop arrangement of feeders with main cables sectionalized makes it possible to cut out main cable sections for repairs or alterations without affecting loads on either side, except momentarily while making the transfer, the load in the meantime being carried by the alternative route. An alternative feed for the more important branch feeders, can be provided where this is essential but this, in many cases, would not be considered necessary as the load affected might not be more than that of a single transformer or bank of transformers.

Where existing overhead lines are being replaced, it may be found useful, at least during the development of the new system, to utilize the original overhead line as the emergency alternative feed, but, in such cases, the overhead line would be left normally dead and only made alive from either end when the emergency connection was required.

The relatively large sizes of conductors made necessary by the provision for the transfer of load from one feeder to another, through the loop system, is reflected normally in decreased feeder losses and improved regulation.

It is evident that whatever condition obtains at the time of installation of a given feeder system, subsequent additions of load will modify this and the maintenance of proper load conditions will require the cutting in of additional feeders and transfer of feeder sections from time to time before maximum permissible loads are reached in individual cables.

In general, it is considered that the placing of all primary feeders underground, in the manner indicated while maintaining existing pole lines for secondaries and service connections, and for street lighting when required, will be of much greater benefit, having regard to the expenditure required, than could be attained by the expenditure of similar sums in the placing of all construction underground in a limited area.

It is felt that by this method of treatment, approximately all the actual operating advantages of complete underground construction may be attained plus the advantages of the loop transfer system which does not appear to be in very common use, but minus the aesthetic feature of pole removal. This latter feature, however, can be worked out later as the desire or necessity may arise, without affecting the usefulness of the primary system.

In a typical case for which the requirements of the described feeder system have been worked out, it has been found that the cost of replacing a system of fully loaded (with some overloaded) overhead feeders, in the manner indicated, approximates 15 per cent. of the total plant value of the system of which it forms a part, and that when the cost of reinforcing the original overhead system to provide similar conductor capacities is considered as an offset, including the renewal of old poles to carry the heavier conductors, the excess cost of the underground feature may be as low as one-third of the total expenditure involved, or approximately a 5 per cent. addition to total plant value.

In the particular case referred to, the value of power losses saved, at the values of sub-station bus, plus a moderate allowance for reduced operating costs in the form of less emergency calls during storms, less actual damage from lightning, wind and sleet, less tree trimming and reduced pole replacements, will amount to fully six to seven per cent. on the net investment required.

In addition to this, reduced interruptions to consumers' service during storms, improved regulation due to the larger conductor sizes used, less annoyance to the public from tree trimming for wire clearances and generally reduced hazards of operation are favorable factors which should be considered as justifying a very substantial effort on the part of those responsible for the distribution of electric power.

In conclusion, this plan is presented in the hopes that the importance of providing the public with increasingly better service from every standpoint will be so fully recognized that surplus funds available in Hydro Electric municipal systems will be devoted to attaining this end to a greater extent than has seemed to be feasible in the past.

Discussion

Mr. C. E. Schwenger, Toronto: I thoroughly agree with what Mr. Jackson says about the desirability of getting primary conductors linked up with the cable system, on account of the fact that they are less exposed to the elements, and to danger of being tampered with by workmen, and to street accidents. One point about the life of the overhead line, however, which he apparently puts at ten years, would seem to indicate that, after ten years, the line has to be entirely rebuilt. I would like to know if that is the case, and if that is due to inferior pole line construction such as, the lack of pole treatment or something of that kind, because it seems to me ten years is quite a low ife to put on that kind of plant. eTen, in regard to the size of the feedhr, 250 M cir. mils, I was wondering if Mr. Jackson would give us a figure on how much load he would normally put on feeders. Another point which might be raised is the question of getting rid of poles. We have developed a concrete pole for Toronto, as you all know, that to my mind, has certain aesthetic features, and I think, for an underground supply, the pole would be in the same service for many years. There is another thought which might be brought up here, and that is the question of standardizing the potheads on the poles. It might be possible to do away with that altogether by using a cut-out of the oil type, which would be buried in the ground along with a buried transformer. Then the whole primary system would be underground. There would be no exposed high voltage wires at all, and you would get a shorter cable as well.

Mr. Jackson: In regard to the question of pole life, the ten-year period was not mentioned with any

reference particularly to life but merely with the idea in mind that, after the original pole had been in use ten or twelve years, the overhead system might be due for revision, and if it obtained its full load, or an approaching overload, that would be an opportune time to consider the installation of a system such as this. Depreciation requiring renewal would ordinarily commence from a period of perhaps twelve to fifteen years in the age of the poles, and from that time on progressively at a greater rate. In general the loading for an existing system, would be presumably about one-half the safe loading of the cable whatever that might be, so that you could transfer an equal load to another feeder section; in comparisons which I have made, any losses have been based on that. Approximately a 50 per cent. load is fully justifiable from the standpoint of power losses saved. At least, it appears to be in the ordinary case. With regard to underground pothead arrangements and junction boxes, I don't feel that that has been sufficiently well developed. I think there is room for considerable improvement. I am not at all clear as to whether there is anything sufficiently useful in that form that is not rather expensive, but the expense or the cost of even the existing equipment is not at all prohibitive.

Mr. Wills Maclachlan, H.E.P.C. of Ontario: I think Mr. Jackson is to be certainly congratulated on bringing forth a paper of this kind. I think, in the past, those designing or building transmission and distribution systems have been too prone to follow the set plan that has been developed by others, and been in force for a number of years without trying to think out some definite plan that will fit each particular case. I do not think there is any doubt that the definite trend of the present time is away from working on primary lines alive. In some of the smaller municipalities in Ontario, it is absolutely criminal to carry out this line of action without the necessary men and without the necessary equipment to do it. You are between the two horns of a dilemma; first, you want to serve your customers and keep power on 24 hours of the day right through, and second, you have neither the men nor the equipment to carry out work on primary lines. I think the idea of putting in a loop system is admirably developed, so that you can cut out a small section of line and still maintain service to most of your customers, and yet be able to have that work done dead. Of course, there is no doubt about it that, putting your primary lines in an underground cable will work not only for the continued efficiency of your distribution system, but will also work for safety to your public, and that is by no means a small factor. Continually, we are having a message come through, "The primary line has come down in a wind storm," or something of this kind, and some youngster has run into the wire or picked it up. A number of those things never get into the papers, but they are too frequent for the comfort of those that really have at heart the safety of the public. As far as the safety to linemen is concerned,

one of your greatest hazards is working on or near primary lines.

As far as the details of it are concerned, the only point that I would like to bring out is that of the suggestion of an underground oil switch to handle the sectionalizing factor of it. Unless you are sure that your section is dead, you are putting a very weak point into your system. In too many cases, there is a broken toggle, or through bad oil or sticky contacts, when you think you have your oil switch open, it is not open. There was one town in this Province when in a sleet storm they thought the oil switch was supposed to be open, when it certainly was not open. For that reason, I am very much in favour of the suggestion of Mr. Jackson in using potheads with some open type of connection between them.

Mr. F. B. Shand, H.E.P.C. of Ontario: Mr. Jackson has brought up the question of the duct system, and the cable laid directly in the ground. In the smaller towns, we have possibly three or four main streets, where the pavement and the sidewalk occupy what you might say the entire distance between the buildings, while on the side streets you have possibly the solid pavement, sidewalk and then lawn or trees. On the main streets you must fall in with the duct system, in that you cannot be continually taking up the pavement for replacement. But on the side streets, where you have the lawn and trees, just what kind of system should be employed? In the larger cities, of course, they have a standard engineering staff, and that point is very well taken care of. But in the smaller towns, people are continually complaining about the lawn being torn up and the shrubs damaged, and the point I would like to emphasize is as to whether the duct system should be carried out throughout a town, rather than change from the duct to the open system.

Mr. Jackson: I want to take exception to one statement in Mr. Shand's remarks, and that is that lawns and shrubs and so on would be continually subject to damage from taking the cable up, because, if it were properly installed, it should be there for a long time. The governing factor, of course, is the question of accessibility. At the same time, there might be some damage, but that damage would be caused if the initial installation were not as it should be. But the trouble would be from other works, such as installing sewers, drains, gas mains and so on, and the workmen punching holes in the cable. Apart from that, you must consider the possibility that at some time or other you will have to do some repairs. If you have not enough cable to put in a standard conduit system, my experience is that wrought iron pipes that have been dug up after being installed for years were still in good condition. Wrought iron gas pipes stand for a long time without leaking gas unduly, and for electric cable, a little hole in the pipe here and there does not make much difference. The pipe is there to protect the cable. Armoured cable has the advantage, that if you do develop a fault at any time, you can, with modern equipment,

trace the location of it very accurately. You can dig up at a point and make a joint easier than pull out a section four, five or six hundred feet long, or make two joints to replace a small section without the necessity of the installation of an entire new length of cable. In other words, the problem of repairs to an armoured cable is very much less than with the regular lead covered cable drawn into any kind of conduit, and for that reason, I advocate it for smaller places where they are not operating under paved surfaces.

Mr. P. B. Yates of St. Catharines: Mr. Jackson, do I understand you would recommend armoured cable in preference to wrought iron pipe on account of its accessibility?

Mr. Jackson: On account of its accessibility, and a somewhat greater carrying capacity, principally accessibility. I am not recommending armoured cable for that purpose without reserve. In boulevard spaces and probably more generally in smaller cities and towns, where a more extreme form of protection of cable is necessary, due to less supervision over it, I would say to put it in iron pipe. I think iron pipe is better protection than armoured cable even, with a plank over it. But if you are going to be able to watch the cable, for instance, if you have men delegated to run over the route whenever any work is being done, they could probably supervise the entire layout of armoured cable, well enough to avoid anyone digging it up or anything like that.

Mr. Yates: After receiving this answer, I would like to thank Mr. Jackson for this paper. It is a most interesting subject, especially at the present time. We are all getting away from, and we have long-since reached the point where a lot of our feeders should be overhauled and rebuilt; and it brings up a very much larger field for the use of the system which the Provincial Commission inaugurated in their rural work. Since we have been doing work for the Provincial Commission in the Townships around St. Catharines, we have started doing some cable work in the City. We find that there are a great many places where the lead covered cable is of great advantage in helping us to reach the desired location for an added transformer. There are some districts where the trees are so very heavy that one cannot get a primary line through, and the lines were kept off the street. We are now putting these underground, using the regular rural construction, with the exception that the lead covered cables under the boulevards are put in in two-inch pipe. This pipe extends to within a foot or so of the pole to leave pulling room there and then the cable comes up the pole in iron pipe or other protection.

Mr. A. L. Mudge, Welland Ship Canal: May I ask Mr. Jackson, what depth he would recommend burying the armoured cable? I presume also that, with the use of armoured cable, unprotected by a pipe, there would not be any question of the necessity of protecting it with a plank. Also would he care to express an opinion as to the best type of installation to use on cables

for the work that he has been discussing here.

Mr. Jackson: Probably the minimum depth would be down to two feet. I would say myself eighteen inches in depth for the installation of either armoured cable or a single pipe. But, of course, this would have to be governed by the question of whether the surface under which you were installing this cable would be subject to a later installation of pavement or anything of that sort. Naturally, these would have to be considered. Paper insulated cable of the standard types, probably gives a very adequate margin of safety. I think it is better, in installing cable for a 4,000 volt service, to use the next highest above that. I think the additional cost is so slight that that would be thoroughly justified, also use a lead sheath, not less than one-eighth of an inch in thickness; .12 in. is a fairly standard thickness, that most manufacturers recommend. Sometimes you can have thinner lead sheaths, but I am very much in favour of making it thick enough so that, if it is scratched in being dragged over the pavement, or being drawn through iron pipe, that this scratch would not penetrate through the lead. I understand from Mr. Schwenger that their experience in Toronto over a considerable period is rather in favour of the cable that we are installing, which is more heavily covered with lead, and somewhat more heavily insulated than the ordinary standard would seem to require.

Mr. R. H. Martindale, Sudbury: We find iron pipe in our section of the country to have a life underground of probably fifteen years. Our experience is based on underground conduits, for low voltage services, and we would like to suggest the merits of fibre conduit. We have some thousands of feet of fibre conduit laid in concrete. The cost of the fibre is roughly one-third of the cost of iron pipe, of the same diameter, not including the cost of the concrete to protect one duct on the exterior surface, and the duct can be very quickly and cheaply laid. It has an indefinite life and a smooth interior.

Mr. H. D. Rothwell, H.E.P.C of Ontario: We have several hundred miles of underground cable laid for rural work. Most of that is installed in a trench, without any protection other than the earth backfilled in on top of it. We have never considered that iron pipe is the right thing to use for pulling lead cable through. In the first place, if you have trouble and a break down in the cable inside the pipe, it is extremely difficult to repair. It must be withdrawn, and in many cases the actual trouble will fuse itself to the side of the pipe. We use, in cases where there are considerable hazards, a plank on top of the cable itself with the exception of railway crossings or some place where the cable must be pushed underneath the track by the use of jacks or other means, and I think that is much superior to the iron pipe. The withdrawing of paper insulated cable, especially in cold weather, means that that section of the cable is practically ruined; and if you can introduce some other

means, I think it is much more preferable.

Mr. Jackson: Mr Chairman, I want to answer that point or comment on it. I have always viewed that with considerable apprehension but I understand the Commission's experience has been quite favourable. But I don't think it is a feasible method in cities and towns, for primary cable though it is sometimes considered quite suitable for services where they can be readily disconnected from the secondary. The experience I have had with iron pipe has not been unfavourable. It is possible to protect it with an asphalt coating inside, and though that does not last forever, the life under ordinary conditions, seems to be well over twenty years. That is, depreciation does not seem to be very much over a period of twenty years, and I suppose the life is very much longer than that. But the question of drawing out a cable is one that has to be seriously considered. I don't think, given proper installation, you can ruin a cable, if it is of any appreciable size, in withdrawing it or in pulling it in. But of course, when you pull a large cable that has a fault, you are apt to be subject to some loss, and you may, in the end, if you are using anything but tile conduit in large sizes, have to dig up the spot in the street where the fault occurs, and that applies to the paper covered cable as well as the to iron pipe. Fibre conduit, of course, is useless unless heavily concreted, but where cost permits it is all right, although I think a single duct would require some other re-enforcements ordinarily. Even the concrete would require some steel to carry the points where there is fill. I just want to stress the point, that I think we should keep away from the idea that we are going to have to pull out long sections of cable at any time. It would be really better to dig them up and avoid replacement of the length between the manholes or the joints in any case.

Mr. Martindale: Probably I was not quite right when I said fifteen years was the life of pipe. I mean the ordinary so-called galvanized iron pipe, without any special treatment, which we find has a life underground of not more than fifteen years before corrosion has eaten through the pipe. If you take that pipe and paint it with asphalt, and wrap it with burlap, and soak the burlap with asphalt, you will get probably a life of twenty-five or thirty years or more. I find by treating it, that we can make iron pipe last a very long time. With respect to fibre conduit, we have had it in use for fifteen years and never had a failure or a break; we have had excavations below and above it, and never had any trouble. Iron pipe, as ordinarily purchased carries burrs and fins but if you are very careful in reaming the pipe, I cannot see that you should have any trouble in the withdrawal.

Mr. O. J. West, Toronto: Speaking of iron pipe, I think it depends altogether on the soil the pipe is in. There is, in the City of Toronto, a lot of the old iron Edison system, which we have to dig up in some cases and we find it just as good as the day it went in, while in other cases the

pipe is eaten away. Of course, if there be any ashes, or anything of that nature, the life of the pipe will not be long. In pulling cable through iron pipe laid in the ground, and not below the frost level, there will probably be a hollow in which water will lie, and in freezing pinch the cable off. We have had some trouble with that. We have found, in putting in cable underground and putting a certain amount of soil over it and then a plank over that to protect it, that it has been a very satisfactory mode of procedure. But the iron pipe, if it is left with a hollow in it, to collect water and freeze will pinch off the cable, especially if the cable is small and the pipe has a large space in it. If it does not do that, it will destroy the lead, and in the Springtime, when the ice melts, water gets into your cable, and you have trouble there anyway.

"Lindy" Pride of Simcoe R. P. D.

Picked up on the Port Rowan highway after a hit and run motorist had broken his wing this morning dove was brought to the office and cared for. The amateur surgery of the local first aid experts was not successful and Lindy will never fly again. He soon became tame and during the winter became so friendly that he was given the run of the office with a box behind the stove for his own use. He has never approved of sweeping and makes it a point to retire to the storeroom when the broom is brought out. This summer he has been kept inside and because a cage is too small he wanders about just keeping clear of the many feet.

A very large bump of curiosity leads him to investigate all the activities of the office and he is now splashed with paint as a result of looking over a tool box as it was being painted. Two dogs have almost succeeded in getting him and only prompt efforts saved him last week from a visitor's dog that pulled out a few feathers.

Simcoe R.P.D. boasts of having the finest office garden in the Hydro and Lindy looks forward to a daily walk and sun bath among the flowers. He likes company on these excursions and is a great help in weeding and

"Lindy" in characteristic poses. At the right he is in a fighting mood, being jealous of his reflection.

each weed is carefully inspected as it is pulled. The photos show Lindy in a few poses.

James H. Shepard, Windsor

It is with regret we record the death of Mr. James H. Shepherd, Commissioner, Windsor Hydro-Electric System, on July 14, 1928. On the Monday of that week, Mr. Shepherd underwent an operation for appendicitis, at which time local peritonitis was diagnosed. This condition, combined with Mr. Shepherd's advanced age of 76, resulted in his death.

Mr. Shepherd was a native of Ottawa but had lived for over half a century in Windsor, being associated for 56 years with the retail business firm of Bartlett, Macdonald & Gow, and its predecessors. At the time of his death he was Manager of the Carpet and Drapery Department.

Mr. Shepherd's career in Windsor was one long devoted to municipal affairs, in fact, municipal life was almost a passion with him. Having served as Alderman for 18 years, he became Mayor of the City in 1912, and it was during his time that Windsor entered the Hydro family, chiefly due to his efforts. Since that time Mr. Shepherd has been a member of the Windsor Hydro Commission, acting either as Chairman or Commissioner.

In tribute to Mr. Shepherd, Mayor C. E. Jackson in recalling happenings in municipal circles stated that "Mr. Shepherd always took a keen and active interest in anything that was for the betterment of the City and its people. His efforts on behalf of Hydro, of course, are too well known to need mention. . . . I sat with him in the Council for years and always found him very fair whether he agreed with you or not. He was, in fact, the type of public servant as stands for the best in a man."

Mr. Shepherd is survived by his widow and two sons and two daughters. They are, Edmund E., Attorney, Detroit; D. Beaumont, a newspaper man in Buffalo; Miss Edith of Detroit, and Mrs. Oliver M. Perry, wife of the Manager of Windsor Hydro-Electric System. To all of these we take this opportunity of extending our sincere sympathy.

J. T. Bridgewater, Dresden

We learned of the death, late in July, of Mr. J. T. Bridgewater, Secretary of Dresden Hydro-Electric System, which came as a shock to those who were intimately acquainted with him.

Mr. Bridgewater was born in England 68 years ago and came to Canada at an early age, living in Dresden practically all his life. His death followed an operation for appendicitis in the Chatham General Hospital. He was village Clerk for 19 years and Secretary of Dresden H. E. S. from its inception. He was also Police Magistrate for the village of Dresden.

Mr. Bridgewater's wife predeceased him several years ago; his one living near relative being a sister, Miss Ann Bridgewater.

Mr. Bridgewater was of a very gentlemanly disposition and very studious. He was a great reader and had a library in his home which was known all over the country. Those

associated with him in Hydro work held him in high esteem, both as to his personality and to the manner in which his work was done.

Soldering Materials for Electrical Work

The following notice in reference to certain soldering materials has been sent in by the Electrical Inspection Department.

The process of soldering, as the term is defined in dictionaries, and as the process itself is usually carried out, is the joining of two metal surfaces, by means of fusion on to them of another metal having a lower melting point than the metal joined. The standard materials used in electrical work for soldering are, as is well known, a suitable alloy of tin and lead and a non-acid flux.

There has recently appeared, however, a so-called "liquid solder," under the trade name "Tisit," in the use of which there is a radical departure from the ordinary practice in soldering in that there is no fusion of the "solder," as this is applied cold.

Tisit, which is supplied in small bottles is displayed in cardboard cartons which bear the words:—"for all uses."

On the bottles themselves no claim is made indicating that this "solder" is good for electric wiring work though it is stated that it "repairs... radios" and is "Not affected by heat or acid."

Tisit has been tested at the Commission's laboratories and the following paragraphs are quoted from the report issued thereon.

"From the chemical and physical tests we made on this so-called cold solder, we are of the opinion that it has its uses—. The surface to be coated should be scratched to furnish a tooth for the film to bond to. It has no leverage power and is useless where strength is required. The binder is inflammable and will not stand high temperatures. It resists acetic acid and other dilute acids."

"Tests were also made to determine if this material would be suitable for —house-wiring. It was found not to be suitable for this work as it forms an insulating film when dry."

"Our tests show this material to be made on a lacquer base with a pigment consisting of aluminum powder."

The makers claim that "Tisit loses its leverage qualities on account of being a liquid—otherwise it will do everything that any other solder will do."

After being applied, which, as already stated, is done without heat, this compound has an appearance similar to that of ordinary solder so that at a casual glance a person might easily mistake it for the real thing.

Because of its lacking in strength, and because it is not a real solder making definite metallic union throughout a joint, it is judged to be quite unsuited for electrical work in lighting and power installations.

It may be taken for granted that soldering, properly done with the usual materials as mentioned above, is considered to be satisfactory for all electrical work, but no new materials such as the one here considered must be employed on such work unless and until they have been approved by the Commission.

It is not intended here to convey the impression that "Tisit" is no good —it is believed to be suitable for a large number of uses of a non-electrical nature, but it should have no place in any electrical installation, possessing, as it does, several characteristics which unfit it for such use.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Toronto-Leaside Transformer Station, general panoramic view from the north-west showing progress to September 15, 1928.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Toronto-Leaside Transformer Station

THE initial block of power to be delivered under the Gatineau 25-cycle contract is 80,000 h.p. The initial instalation provided to handle this power is one 220 kv. transmission circuit with two banks of 45,000 kv-a. transformers in the terminal station at Leaside. The panoramic view attached shows the first unit of the terminal station as it appeared in September 15th.

It is noticed that the initial installation is all in the foreground from the railway siding entering the picture from the left. This siding passes down the centre of the 12 acres of the station site and this initial installation is to be duplicated on the opposite side of the siding to handle the full 250,000 h.p. of the Gatineau contract. Ultimately it is possible that 360,000 kv-a. will be the installed capacity at this station (8 banks of transformers), the site providing sufficient area for this capacity.

Following the flow of power through the station, we see the 220 kv. line entering at the left of Sec. 1 of the picture. The line here is on special towers, much lower than on the remainder of the line, with towers spaced at approximately 600 feet, instead of over 1,000 ft. Only 14 insulator units are provided instead of 18, but four ground wires are installed instead of only two. These precautions are taken to protect the station from dangerous lightning surges coming in from the lines.

The 220 kv. switching is seen in Sec. 1, with the 220 kv. busses in secs. 2 and 3. The tremendous size of the 220 kv. equipment and the area required to provide adequate clearances between the 220 kv. busses is seen in this view. A complete 220 kv. oil circuit breaker weighs 105 tons.

The high towers in Sec. 3 carry the transformer leads from the corresponding towers in Sec. 1, the pinnacles on the structures being for the ground

CONTENTS

Vol. XV **No. 9**

September, 1928

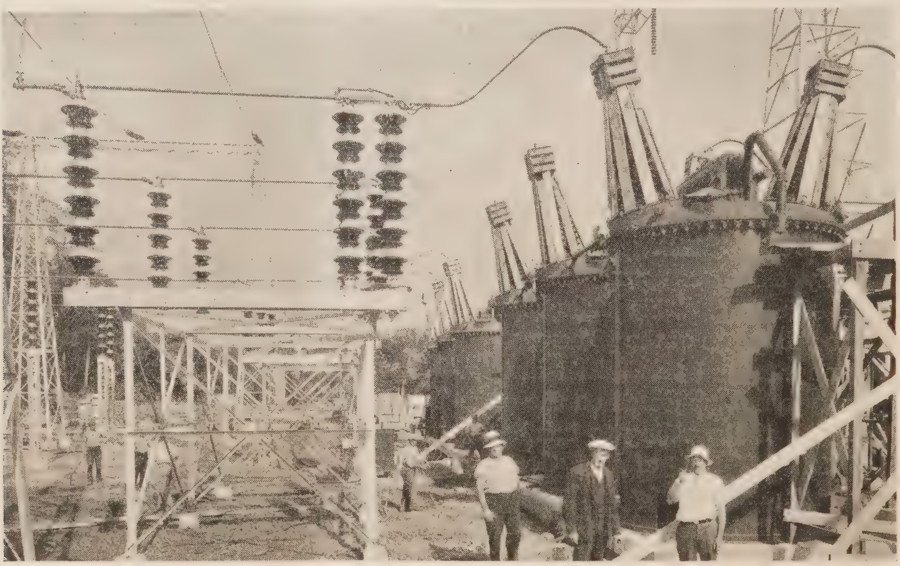
	Page
Toronto-Leaside Transformer Station	293
Interim Report of Special International Niagara Board	298
Application of Hydro-Electric Power to Farm Work	304
Commercial Flying	308
The Parable of the Range in the Parlor	313
A.M.E.U. Notes	316
Hydro News Items	321

wires which are carried from the line on over the station.

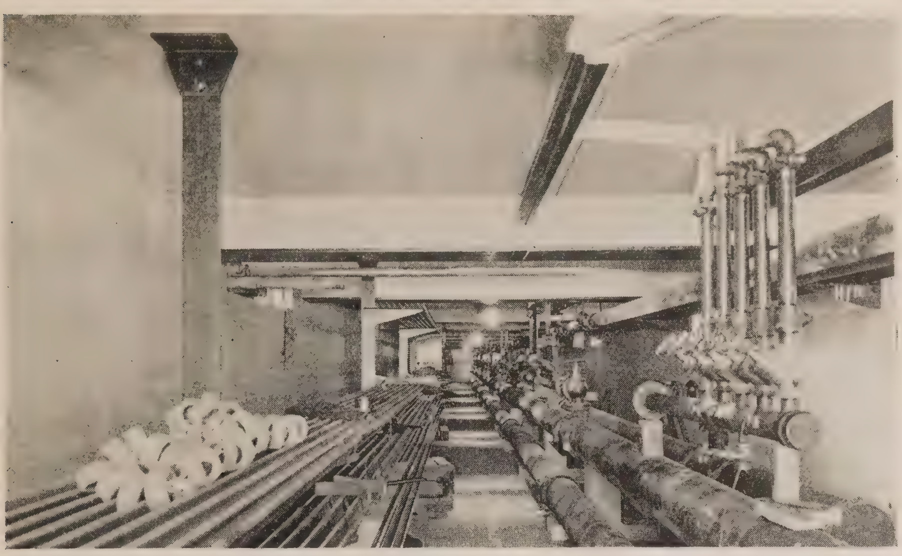
The Service Building (for transformer erection, etc.,) is seen in the background of Sec. 3, with the foundations for the transformers leading into the foreground from it.

The 15,000 kv-a. single phase transformers may be seen in Sec. 3, located on their foundations, there being seven of these units for this installation, two banks and one spare. It will be noticed that the transformer tank is in three sections. This was dictated by shipping facilities, the transformers being the very largest that could be built in Hamilton and shipped to Toronto. The complete transformer weighs 184 tons.

In Sec. 4 is seen the 13.2 kv. switch building, containing the Toronto H.E.S. feeder switches, reactor bus tie and condenser switches. With the 13.2 kv. arrangement selected for Leaside it will not be necessary for the T.H.E.S., to have a separate switch building, but power will be "trunked," by means of 15,000 kv-a. capacity underground feeders, to their distributing stations, Carlaw Avenue, etc.



Some of the 220 kv. disconnecting switches and oil circuit breakers. The circuit breakers are rated to interrupt a fault current of 2,500,000 kv-a.



The tunnel beneath the transformer foundations, showing the cooling water circulating pipes, oil pipes and corrugated pans for carrying the control and meter cables.

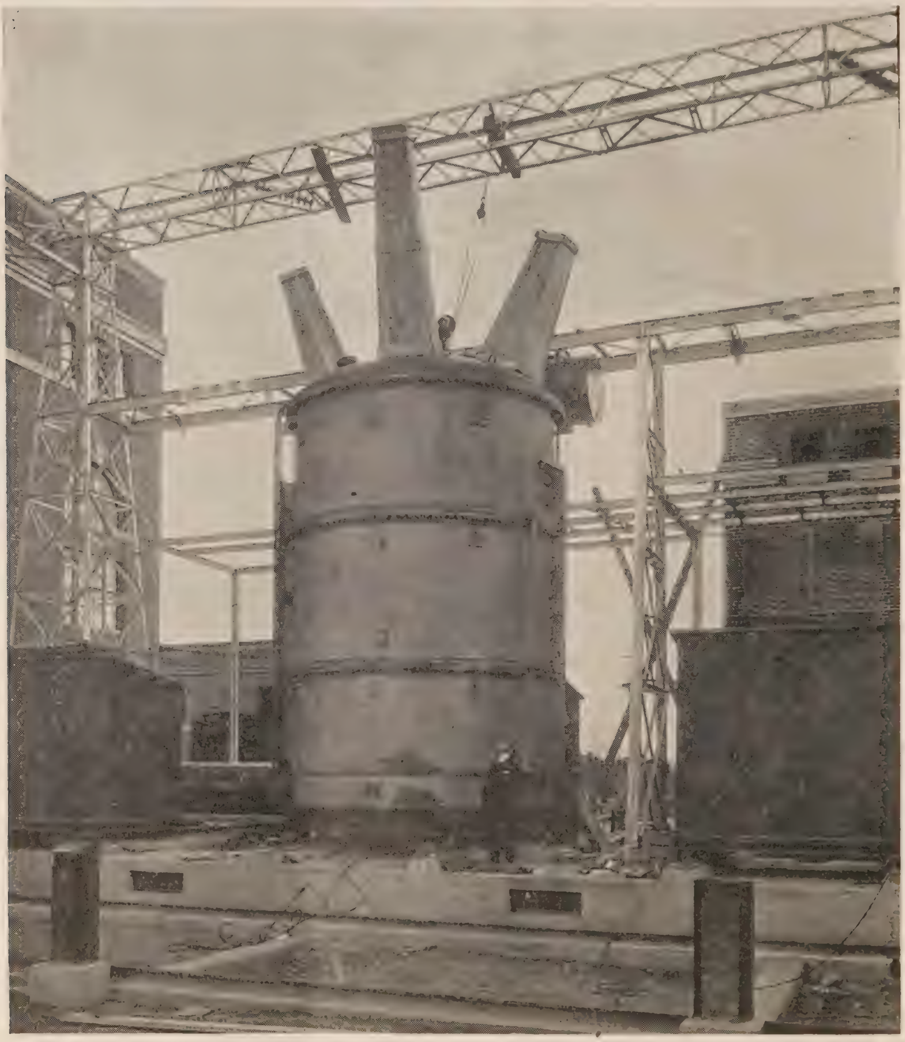
Immediately behind the 13.2 kv. building, but not visible in the picture, is the Control Building. This building is situated practically in the centre of the site, the 220 kv. equipment being in front of it, the 13.2 kv. to the side, the 110 kv. to the side and rear, and the condensers when installed will be to the rear.

In addition to the Control Building, a 220 kv. Relay Building is provided, the small brick building behind the

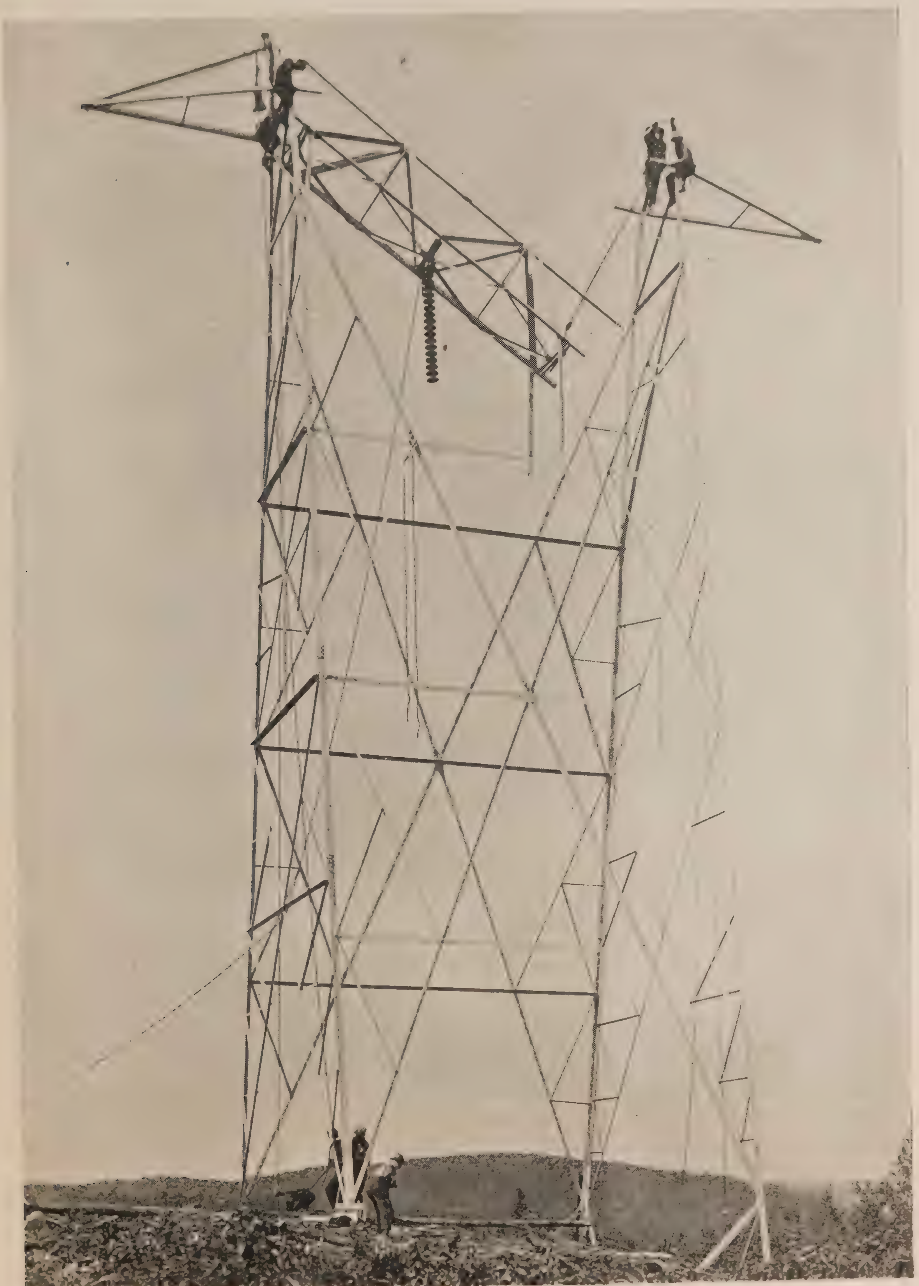
Stringing conductors in the bad country approximately 150 miles east of Toronto.

steel structures in Sec. 2. This building is located in the centre of the 220 kv. layout and all the 220 kv. relay and control wiring converges on it. Connection is provided between this building and the control room by tunnel.

The 110 kv. switching structure is seen in Sec. 5. The 110 kv. power from two banks of transformers



One of the 15,000 kv-a. single-phase, three winding transformers on its foundations. One of these units when filled with oil weighs 184 tons. The 220 kv. and 110. kv. bushings are seen on the top of the tank, the 13.2 kv. terminals being brought out the side of the tank, to the rear. The 110 kv., tap changing apparatus for the adjacent units may be seen on the tracks beside this transformer.



Final operation in tower erection, raising the centre section of the cross-arm.

passes through this part of the station on its way to Commission's Bridgman Avenue Transformer Station. The first tower on the 110 kv. Tie line, which follows the C.P.R. right of way between the two stations, is seen to the left in Sec. 6.

In the foreground of Sec. 6 is seen the transformer cooling-pond. For the initial installation of two banks of transformers, 650,000 gallons of water per day must be pumped through the cooling system, as much water as a town of about 7,500 people would use. In other words approximately 600 h.p. must be dissipated into the air by the spray nozzles.

Interim Report of Special International Niagara Board

AN interim report of the Special International Niagara Board was submitted to the Governments of Canada and the United States about the close of 1927. The following are excerpts from that report, giving a brief outline, of the problem presented, remedies proposed to preserve the scenic effects and the advantages anticipated.

The Special International Niagara Board was appointed by the Governments of Canada and the United States to investigate and report upon the Falls of Niagara and the factors bearing upon the preservation of their scenic beauty, pending the completion of its final study, and in conformity with the Terms of Reference which provide that the Board "make such progress reports as may be appropriate."

The objective of the Special Board's investigation was, in brief, the determination of how the scenic beauty of Niagara Falls and rapids can best be maintained and by what means and to what extent the impairment thereof by erosion or otherwise can be overcome and, consistent with the preservation of the scenic beauty of the Falls and river, of determining what quantity of water, additional to that permitted to be diverted by the Boundary Waters Treaty, might be diverted either temporarily or permanently.

While the investigations of the Special Board are not complete, they are sufficiently advanced to permit of the submission at this time to the two Governments of certain conclusions and recommendations with respect to initial remedial measures which might be profitably undertaken in the immediate future.

The general appearance of the Falls has been the subject of serious consideration by the two Governments since 1905 Several conditions have been developing which have reacted directly upon their scenic beauty.

(*a*) Surveys made in the years 1764, 1842, 1875, 1906 1917, 1925 and 1927 indicate a continuous recession of the central portion of the crestline of the Canadian or Horseshoe Falls. The effect of this recession has been to lengthen the crest and to leave the flanks of the Horseshoe on

either shore more or less denuded of water, the degree depending upon the total volume of the flow over the Falls.

(*b*) The low cycle of levels in the Great Lakes System for several years past, culminating in the extreme low water of 1925-26, has been reflected in the flows of Niagara River which reached the minimum on record in February, 1926. These low flows have augmented the baring of the flanks of the Horseshoe Falls and reduced the supply available for the American Falls.

(*c*) The withdrawal of water from the Great Lakes and the Niagara River for navigation, sanitary and power purposes, has had the effect of reducing the total flow available for the Falls and rapids immediately above, by gradually increasing amounts from a yearly average of 900 cubic feet per second in the year 1860 to some 64,000 cubic feet per second in 1927. Of this total, about 12,000 cubic feet per second is diverted from the Great Lakes System through the works of the Chicago Sanitary District, the Welland Canal, and the New York State Barge Canal. The power water at Niagara is limited by the treaty to "not exceeding in the aggregate a daily diversion at the rate of" 56,000 cubic feet of water per second. At present this authorized power diversion is utilized to the fullest extent practicable with present installations, resulting in diversions during the year immediately preceding the date of this report as follows:

Average annual diversion	52,075 c.f.s.
Average Sunday diversion	42,766 c.f.s.
Average weekday diversion	53,625 c.f.s.
Average weekday diversion during daylight hours, about	61,000 c.f.s.

This withdrawal of water has reduced the flow in both the American and Canadian channels and has increased the unwatering of the flanks of the Horseshoe. At the same time this reduction in the total flow has in some measure retarded the rate of erosion.

The rate at which the central part of the Horseshoe moves upstream has been several times calculated in recent years, the determined rate in each case depending somewhat upon the definition given to the movement and the method used in the calculation. The latest determination made by this board, with the aid of competent geologists and considering only the actively cutting central part of the fall shows a mean rate of recession of the crest of 3.7 feet per year since 1842, and of 2.3 feet per year since 1906. The direction of maximum recession is now and has been for more than twenty years up the deep channel on the Canadian side and not in the so-called "notch" where of recent years the recession has been almost negligible. The Horseshoe is now cutting back at a decreasing rate and the rate will continue to decrease.

As the Falls recede the active part of the crest line will increase in length, and, even assuming no further diversion, the flow per unit of crest will decrease. It is estimated that by the year 2100 the length of the active part of the crest line will be about 75 per cent greater than at present. At that time the average flow per unit of crest will be between one-half and two-thirds of the present flow. This natural thinning out of the flow will decrease the rate of recession.

Thus it is apparent that, if left to itself, the Horseshoe Fall will not become a mere cascade or destroy itself by cutting a deep 'notch.' On the contrary, there is every reason to believe that the active part of the Horseshoe will broaden out and the crest line lengthen in graceful curves and that, if adequately supplied with water, the main part of the Horseshoe, 100 or 200 years hence, will

present an appearance equal or superior to the present. It is estimated that recession will not progress to the point of draining the American Falls for at least 2,000 years.

The recession of the American Falls is negligible. In the time since these falls became separated from the Horseshoe, the crest line has not receded much, if any, more than the dry crest of the adjacent walls of the gorge. This condition is due to the fact that the flow over the flank of the main fall as it receded along and past the face of the present American Falls was not sufficient to cut through the hard stratum at the foot, thus leaving a resting place for the huge masses of rock which fell from the cliff and which now form the talus at the foot of the Falls. There has never been a sufficient flow over the American Falls to cause any material wearing away of this talus, which, so long as it exists prevents under cutting and consequent erosion.

Low flow over the Falls results in a marked thinning out of the sheet of water, leaving the cliff behind the Falls visible through the curtain at certain points and in certain lights. It also gives an angular appearance to the crest, as the water merely falls over the edge of the cliff instead of leaping clear as it does with higher flows. The thinning out of the upper rapids, with consequent exposure of dry ledges, also detracts from the scenic effect at low flows. These defects can easily be remedied by increasing the low water flow through the American channel by from 2,500 to 3,000 cubic feet per second.

These facts and conditions in conjunction with others developed in the Board's investigations afford, therefore, ample basis for the conclusion that with adequate action supervision and control by the two Governments, the scenic beauty of the Falls can be preserved for the enjoyment of future generations, and that by suitable remedial works designed to distribute the water over the presently bared flanks of the Canadian Falls and to ensure a more dependable flow over the American Falls, the tendency towards erosion in the bend of the Horseshoe can be modified to some extent and at the same time an enhancement of the present scenic beauty of the spectacle as a whole can be ensured.

Proposed Remedial Works: The Falls are in no danger of 'committing suicide' and, even if such were the case, the thinning out of the central flow of water would only retard erosion and not stop it. For these reasons the Board has rejected plans involving elaborate works in the main part of the rapids as unnecessary to accomplish the desired results and as destructive of some of the principal natural scenic effects. The type of construction considered by the Board as best suited to properly rewater the flanks of the Horseshoe is a combination of excavations and submerged weirs carried from the shores near the flanks into the adjacent main currents only far enough to accomplish the desired deflection of water to the flanks. This plan is susceptible of progressive extension upstream and into the rapids to the extent required to mask the effect of any reasonable additional diversions which may be agreed upon.

United States flank of Horseshoe: The laying bare of the Goat Island shelf is most serious, because this is a prominent feature which should, and did formerly, carry enough water to bind the two falls into a single harmonious picture, but which, with the present meagre flow, gives the immediate impression of inadequate water supply. This part of the falls can be given an ample sheet of water through the construction of relatively simple and inexpensive works. These remedial works will take the form of submerged weirs with incidental and co-ordinated excavation designed to deflect water from the heavy current to the north of the central shoal, to distribute the water over the floor of the shelf and to the crest of the Falls, and to be merged into the general effect of the existing cascades. A flow not to exceed 4,000 cubic feet per second, at low stages, is believed sufficient to produce the results desired.

Canadian flank of Horseshoe: Conditions on the Canadian flank of the Horseshoe, while not quite so serious as those obtaining on the Goat Island shelf, are of the same general character and are susceptible of the same type of treatment.

It is proposed that the works in this area shall consist of the removal of exposed boulders and shoals in conjunction with the construction of submerged deflecting weirs lying diagonally and irregularly across the current and intercepting a portion of the heavy flow in the channel to the south of the central shoal, together with such co-ordinated excavation as may be necessary.

The effect of these works will be to distribute to the Canadian flank sufficient water to restore its crest line and re-water the rapids immediaately above. The water required to be drawn from the deeper channel to ensure this effect during periods of low water should not exceed 2,000 cubic feet per second.

American Falls. The lack of volume of the American Falls and rapids and of the flow around Three Sister Islands can be remedied by raising the level of the Grass Island Pool approximately one foot at low stages so as to throw more water against the head of Goat Island. The construction of a submerged weir is the logical method of raising the Pool to the desired elevation. Such a structure, extending irregularly across the current, with possibly auxiliary structures if required, would be quite inconspicuous, probably resulting in nothing more than a very slight ripple or rapid. It could be of rubblemound construction, submerged so deeply as to create no obstruction to the flow of ice.

Cost Estimates. The basic estimates herewith submitted contemplate extending the works to the point where proper scenic effects will be ensured at stages 20,000 cubic feet per second lower than heretofore recorded in the lowest cycle of runoff. The allowance for changes and contingencies has been set at 50 per cent for the works at the flanks and 25 per cent. for the weir in the Grass Island Pool. Upon the above bases estimates have been prepared with as much care as the nature of the work permits and are submitted as follows:

For works at the United States Flank of the Horseshoe Falls....$300,000
Changes and contingencies..$150,000
For works at the Canadian Flank of the Horseshoe Falls....$200,000
Changes and contingencies..$100,000
For works in the Chippewa-Grass Island Pool..............$800,000
Changes and contingencies..$200,000
Total $1,750,000

A further and most important end, which this initial construction serves, is the opportunity afforded the two Governments to actually test out in practice the effect of temporary additional withdrawals of water and the efficiency of remedial works to offset such withdrawals.

Adequate facilities for additional water passage can be provided in the existing power stations on both sides of the river to permit of substantial additional withdrawals of water at such times and for such periods as will most effectively demonstrate the sufficiency of the remedial works to offset the same. No more effective demonstration is possible than that provided by direct observation on the Falls themselves.

The Special International Niagara Board is composed of the following:

CANADIAN MEMBERS:

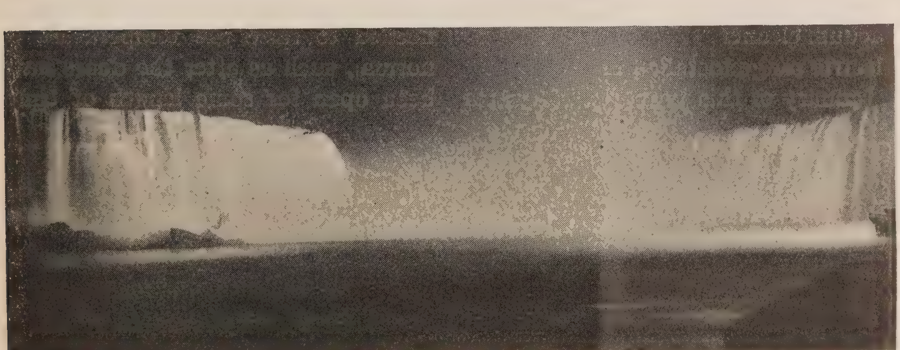
J. T. Johnson, C.E., M.E.I.C., Director, Dominion Water Power & Reclamation Service, Department of the Interior, Ottawa.

Chas. Camsell, LL.D., F.R.S.C., Deputy Miniser of Mines, Ottawa.

UNITED STATES MEMBERS:

DeWitt C. Jones, Major, Corps of Engineers U.S. Army District Engineer at Buffalo, N.Y.

J. Horace McFarland, L.H.D., Past President of the American Civic Association and Chairman of the Fine Arts Commission of the State of Pennsylvania, Harrisburg, Pa.



Application of Hydro-Electric Power to Farm Work

Article No. 15

AN interesting application of hydro electric power to poultry farm work is the subject of this article.

In the Woodstock Rural Power District, Mr. F. E. Ellis, about two years ago, equipped his farm which is located just west of Woodstock, so as to take care of a growing need in this district, of incubating eggs and the sale of day-old chicks. The installed capacity of this place is as follows:

Lighting in house barn and chicken pens	2,000 watts
Electric iron in house	600 "
¼ h.p. motor and washing machine	186 "
1/6 h.p. motor on the furnace blower	125 "
¼ h.p. motor on the automatic water pumping system installed in the well	186 watts
Vacuum cleaner	80 "
Electric range installed in January of this year	8,250 watts
A 20,000-egg electric incubator. In heaters	2,070 watts
½ h.p. motor on the air circulator	376 watts
Total	13,873 watts

The service supplied to this place is under a class 3 contract and the rate for the year was:

Service Charge, $3.40 per month.

Consumption Charge, 3c per kw-hr. for the first forty-two kilowatt-hours used in any month, and 2c per kw-hr. for balance of the consumption

Prompt payment discount 10%.

Prior to January the incubator was 13,000 eggs capacity, and at that time he made changes to enlarge it to 20,000 eggs

There are six heating elements in the incubator of 345 watts each. Four of these are operated by thermostats, and two by hand when needed to raise the temperature to normal, such as after the doors have been open for some length of time,

A panoramic view from the end of the chicken pens looking into the Thames Valley. A number of the colony houses, but not all of them, are shown to the right.

The 20,000-egg electric incubator.

Sections of the kitchen and dining-room showing electric range, electric iron, vacuum cleaner, and lighting arrangement.

A corner of the living-room showing the lighting arrangements.

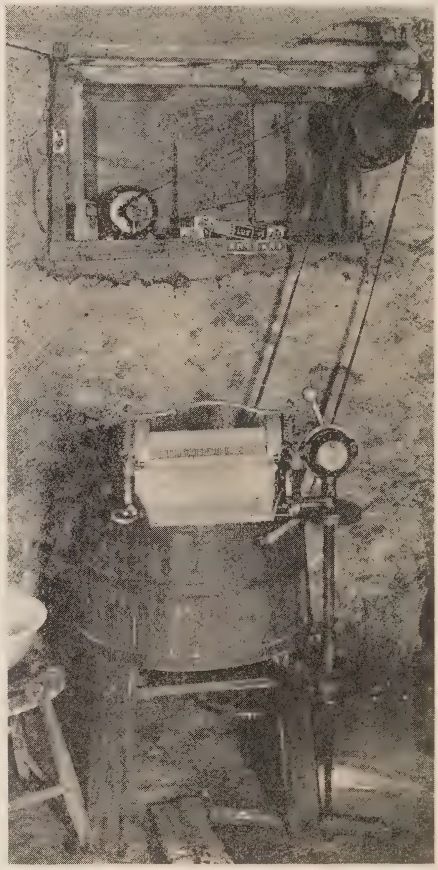
or when starting the incubator for the first run of the season.

The one-half horsepower motor listed above is used for circulating air inside the incubator, so as to eliminate hot or cool spots. During the period of the run this motor operates continuously. The hatch is usually started early in February, and continues until the end of June. This year's hatch was 37,000 chicks being 60 per cent. of the total eggs put into the incubator.

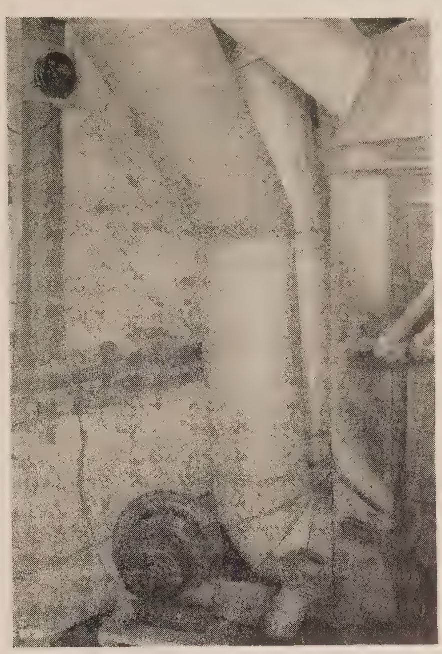
The whole premises including chicken houses is supplied for water service by an automatic deep well pump installed ten or fifteen feet down in the well. The installation was made in the well for protection from frost as well as to decrease the lift.

So far interruptions have in no way interfered with the operations of the incubator. Mr. Ellis is unstinting in his praise of this method of hatching chickens

It is to be noted that even with the uses of the electric range for the six months' period in the record the total consumption and cost on this place is quite reasonable. Below



One-quarter horsepower motor belted through a line shafting to the washing machine. The ordinary power washing machine is found in many farm homes adapted to the new form of drive.



The electric blower on the house furnace. A blower of this type makes it possible for the owner to use small size coal which, of course, is secured to-day at a much lower cost than the larger size. Hot water is supplied during the winter months through a ring in the furnace.

is submitted a thirteen months' record of consumption and costs. It is to be noted that when this is reduced to a twelve months' basis the total consumption was 5,207 kilowatt-hours and the cost $135.05.

CONSUMPTION AND COST OF SERVICE

Class of Service	Period	Ser. Chg.	Kilowatt-Hours Total	1st Rate	2nd Rate	Total Bill
3	4 mths. ending Oct. 31	$12.34	368	168	200	$20.38
	3 " " Jan. 30	9.18	465	126	339	18.68
	3 " " Apr. 30	9.18	2595	126	2469	57.02
	3 " " July 31	9.18	1871	126	1745	43.99
		$39.88	5299	546	4753	$140.07

Commercial Flying

By A. E. Davison, Transmission Engineer, H.E.P.C. of Ont.

THE crowd milled to and fro about the plane. Two mail vans lumbered drunkenly across the drome. There was noise, bustle, confusion.

The mail bags were unloaded, loaded again. The post office men appeared to be working against time, —adolescently. There was more bustle; more hurry.

"All aboard," said Capt. Saunders. "His Majesty's mail cannot wait."

With—let it be confessed at once—a feeling of acute but suppressed nervousness, I climbed into the cabin. Through the courtesy of Canadian Airways, the Hydro-Electric Power Commission of Ontario had been invited to send a representative on the escort mail plane so as to be familiar with the value of the plane for power line inspection and patrol service. The pleasure was mine. Two other passengers climbed aboard, seasoned flyers. The pilot took his seat. A mechanic turned the crank and there was a whirr, whirr, whirr as the starter functioned. Suddenly there was a sputter which became a roar and we moved forward. Imperceptibly, almost, we left the ground. We started to climb like an elevator, up, up, up; but there was no sensation of being at dizzy height; no cause for nervousness—either acute or suppressed. Only a feeling of detachment from the world; a complete and pleasing detachment.

"Where do you want to go?" The pilot turned half around in his seat. "Would you like to see the new Gatineau-Toronto line which we photographed?"

No good trying to shout down a Wright Whirlwind while getting my "air legs." I nodded and a minute or two later I could see the sheen of the galvanized towers and reflection from the large new aluminum conductors below. It was easy to spot the towers for here and there were clearings in the bush. At three to four thousand feet, which is a suitable flying height, the continuity of the wire could be observed and extraordinary conditions, for instance, limbs of trees blown into the line could be distinguished as there is time at this height to survey each span and structure for irregularities, although one is travelling at from 100 to 130 miles per hour. Such observations

Aeroplane Patrol and escort, ready to take off at Leaside, Toronto.

The passengers on the trip.

could not be made even if it were safe to fly low at say 200 feet from the line, because each structure would not be within the field of vision long enough.

"Rice Lake," shouted the pilot. "Which way?" "South" I told him, as there was a 110,000 volt line being built by the Commission between Oshawa and Trenton. Presently this line was picked out some five to seven miles on our right. The structures could be pointed out to others in the plane who were not familiar with either the district or the type of structure.

One's sense of proportion and of speed has to be revised somewhat in the air. It is a long way around Rice Lake to those who have negotiated the whole distance especially the hilly south side of it by automobile, but now when you could look across Lake Ontario and follow the New York shore line in some detail, Rice Lake had become a back-yard puddle. Travelling Toronto to Montreal, it did not matter much which side was taken.

Then when it came to following the details of this line—"Move over a couple of concessions (2 or 3 miles) so that we can see better just what is being done." No sooner said than done. In a few minutes we had "slipped" over to a position where the route and line details could be most satisfactorily studied. The ends of wires on the structures could be seen where a stringing gang was at work, then the pairs of poles could be picked out already in position but empty, later the holes dug ready to receive poles which were lying ready for erection and other holes to receive the logs or "dead-men" which would serve to anchor the guys.

Mr. Saunders pointed out a long load on a nearby highway—"That must be poles," he said and presently the load turned off the road and stopped at vacant holes to unload a pair of poles. A complete progress report on fifty miles of such work could be arranged during one hour away from the flying field.

Airplane line patrol is not a new thing since the Arkansas Power and Light Company have used airplanes to patrol their high voltage lines when the structures were in 10 to 15 feet of water during the Mississippi floods of 1927. They say that "when a line goes out and it is necessary to find trouble in the shortest time the plane is sent out. Since the flood emergency the airplane has located four line breaks, doing the job in each case in only a small fraction of the time that would have been necessary if the trouble had been hunted on foot or by automobile.—In addition to line work the plane has been very useful in making urgent deliveries of

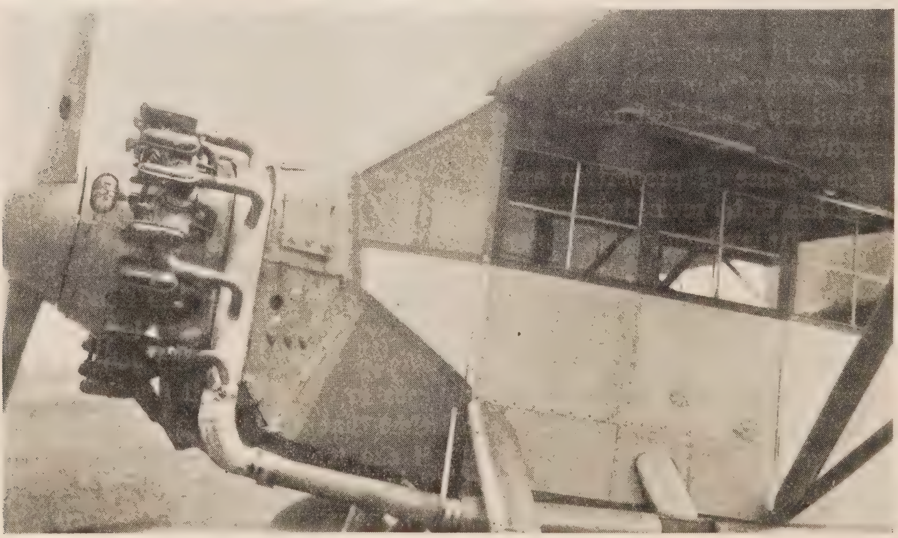
small parts and equipment.*"—In the period from May 4th, 1927, to March 2nd, 1928, their plane travelled about 26,000 miles and was in the air about 300 hours.

Records of performance of commercial airplanes are very interesting as reported by M. V. Shebat. He points out that "—passengers can be transported by air between these two terminals (400 miles apart) at a cost of from 0.9 cents per passenger mile to 27.11 cents per passenger mile, depending on the trips flown and the number of passengers per trip. The lower figure of 0.9 cents per passenger mile applies to a six passenger plane making eight trips per month with capacity load and using part time of one pilot and one mechanic."** In every case where more than two passengers are carried, or where two passengers are carried by a part time pilot-mechanic, he reports the net cost is less than three cents per mile. Mr. Shebat's costs include depreciation based on known life of a number of planes, interest at 7 per cent., hangar rentals, mechanic's and pilot's time, maintenance and gas and oil, there being no allowance for insurance of equipment or personel.

*Electrical World, April 14, 1928, p. 760.

**Eng'g. Dept, Atmospheric Nitrogen Corporation, Stone and Webster Journal, June, 1928, p. 793.

Records of flying routes as reported at the recent N.E.L.A. Convention at Atlantic City are interesting. Mr. W. P. MacCracken says "—one of the air transport operators has flown over 2,000,000 miles, operating both day and night, with a loss of only one pilot and without injury to passenger or cargo, and several others have records equally good—." Mr. MacCracken refers incidentally to one matter which will be interesting to electrical supply organizations when he estimates that aeronautical consumers in United States will pay from one-half to one million dollars per year for light and power.



Fairchild Monoplane engine, and heated, four-seater cabin.

Oblique Photograph taken from an aeroplane. The black areas are lakes, the white, probably dry sandy fields.

As to accident insurance, Mr. MacCracken says "Perhaps it would carry more conviction if your attention were called to the fact that some 30 accident insurance companies have without extra premium, issued riders to their policy holders covering them in the event of an accident while travelling as passengers in licensed aircraft operating on a regularly established air-way. Needless to say the insurance companies would not have taken this attitude unless they felt that air transportation when properly supervised and managed is reasonably safe." As government regulations of commercial flying develop, air passengers may look forward to that double indemnity clause for air-craft which is so popular and so freely written into accident policies where rail or steamboat transportation is involved. Doubtless the Canadian Pacific Express Company are insuring express packages carried over the new air route which they report as follows: ". . . . the establishment of Canada's first regular package express air service through contract between the C.P.E. Co. and the companies operating the mail services. . . . was successfully inaugurated with the Toronto and Ottawa services, these cities receiving package express from arriving vessels via Montreal. . . ."***

***Agricultural and Industrial progress of Canada, July, 1928, p. 133.

But we must keep to our story. There was plenty of opportunity to study surface conditions and make observations as the plane is, during good weather and with a good pilot, if anything, more stable than an auto travelling at 30 miles per hour on a country road. At any rate you are not troubled at all by close up shade trees passing swiftly across the field of vision.

Three hours after leaving Leaside we were over Montreal Island and a few minutes later had landed at Cartierville flying field.—"Where from?" said one of many Frenchmen, standing in groups about the field.—"From Toronto," we said. The Frenchman shrugged his shoulders. That conversation brings out an interesting point. When a plane appears over a flying field it is practically impossible to guess the place from which it comes. It is not convenient to observe which track it has used as on a railway and furthermore, the direction of landing is largely controlled by the state of the field and direction of the wind, rather than by the general direction from which the plane has come.

There was much activity at the Montreal field—larger crowds than at Toronto. The late Mr. Loewenstein's plane was there. "He will leave for Ottawa during the next 10 or 15 minutes." He had done so before we were out of sight of the flying field. There was a large crowd around a 2-engine machine, which was being loaded with mail from Montreal and Toronto for Rimouski. Pilot Schiller had used it in rescuing the trans-Atlantic flyers at Greenly Island. Several other machines were in evidence, one particularly interesting in that its wings were folded back along the fuselage.

Photographs are reproduced including general views of the flying field on Montreal Island with the large mail plane loading for Rimouski and of the flying field at Leaside, Toronto, with mail-plane and escort ready to

Two engine Fairchild plane loading mail at Montreal for Rimouski. This plane made the trip to Greenly Isle.

take off. Other photographs show the three passengers on the trip with Major Wemp of the Board of Control of Toronto in the centre, also details of the single rotary engine and enclosed and heated four-seater cabin.

The large photograph is an "oblique" view and is a good example of what may be expected from the window of an enclosed plane. This and similar views were used in the preliminary work of locating the Commission's 220-kv. lines between the Ottawa River and Toronto district. The black areas are lakes. The white spots are likely sandy dry fields.

The Parable of the Range in the Parlor

By Earl Whitehorne

ONCE upon a time a certain salesman called upon the general manager of a certain power company. He knew him well and when he came in the G.M. shut the door and began to tear his hair and curse the gas company. It was a sad, sad story he had to tell.

It seems that this general manager six months ago, in a sparkling moment, had one day in a much-advertised contest given away to a fortunate customer one electric range. It was a beautiful big range, replete with hot and cold folding doors, gold fingernails and all the latest improvements. It was delivered to the modest home of one John Doe and deposited in the parlour—for there was no room in the kitchen.

Now John Doe was delighted and so was Jenny and so were little Jack and the baby to have possession of this lovely thing. And John immediately sent for an electrical contractor to see about getting this fine and noble cook stove to work. The contractor found, of course, that the wiring in the little home of the Does would not carry a range and figured out an estimate on running a new service, a range circuit, installing the necessary switches, and so forth. The cost would be $65, he told John.

And then John said, "Why, what is all this $65 for?"

The contractor explained that John's service was inadequate. He had ¾-in. conduit, two No. 10 wires and a 30-amp meter service switch. The first thing the contractor would have to do would be to tear out this old service and in its place install 1-¼ in. conduit, three No. 6 wires and a 60-amp meter service switch, and then run wires from the service up to the kitchen. The big cost of the installation would be the meter service.

"Well," John said, "I can't understand why big enough service wasn't put in at the time the house was built."

The contractor said, "Well, you're right. If it had been done then it would only have cost you around $15 instead of $65 to connect this range up now."

The range continued to encumber the parlour. This is a true story and the facts must be faced.

Now there came one evening to the home of the Does two friends to call. And the man friend said to John, "What's that there in the corner?"

"It's an electric range," said John, and he told them the wonderful story of how they won this hifalutin' and expensive luxury in a contest.

"Well, what's it for?" asked the friend.

"Why, to cook with," answered John.

"Well, what's it doing in here?" exclaimed the friend. "Why don't you put it in the kitchen and use it?" And then Jenny Doe explained, as wives will. They couldn't afford to rewire their house in order to connect it. Maybe they couldn't afford to use it. But they had it.

Well, to cut a long tale short, they all went out into the kitchen to look at the place where it might be put—as people do—and there was the old bedraggled gas range. And then the friend gave birth to an idea.

"Why don't you see if you can't exchange it for a new gas range?" said he. That was an exciting moment. So it was when the man came from the gas company. He also had an idea. Of course, they were not in the electric range business, but why did the Does want to fool with an electric stove that would ruin them if they ever tried to cook on it. Let's get right down and see some nice new gas ranges. Now here's this bee-utiful new gas cabinet range with extra double X enamel and nickel knuckles. It costs $150, but we will deliver it to your house and connect it up absolutely without charge and cart away your old black gas range and remove your despicable $350 electric range right out of the parlour. Who wants a range in the parlour anyhow? The idea! Thus the salesman.

And that is just what happened. And then next week in the big front window of the gas company was an interesting exhibit. A large gray electric range—in a gas window, mind you—and there was a great placard that read: "John Doe won this electric range in a contest. It cost him nothing. But he found that it would cost him so much to have it wired up and then to use it that he came down here and bought a No. 17 Young Bride's Delight and asked us to take this off his hands"—or words to that effect.

And the general manager of the power company threatened and swore. And his friend the salesman said, "Wait a minute, I know the gas man. Let me go and see of I can't straighten it out. And he went and he did.

Service Inadequacy

And then this salesman got to thinking and he went back to his friend the general manager of the power company and told him that the fatal electric range was no more in the gas office window. And he asked him a question. "Why is it," he said, "that this kind of thing can happen, that a man can win a beautiful electric range and take it home delighted with it and then not be able to use it and finally throw it out and pay his fuel money to the gas company? What's wrong with us in the electrical industry?" And then he told him.

"Did it ever occur to you," he asked the G.M., "that through the 40 years we electrical men have been connecting houses to the power systems of America—until we've got some seventeen million and a half—that in practically every house we have deliberately blocked our future market? Consider these four things:

1. When the gas company takes on a customer it installs a service and a meter. In the beginning there may be just a small range in the kitchen. But later if the customer decides to have a gas water heater or a gas radiator he simply installs it and connects it. The meter and the service are adequate.

2. When the water company runs a service to a house and sets a meter there may be only one bathroom and a kitchen sink. But later if the family wants two more baths and a downstairs toilet there is no trouble about it. The service and the meter are ready. There is no need to go to the city for a permit and to pay for a bigger main and a more costly service. You use the water you want.

3. And just so, when you have a telephone put in, your idea is that you desire to talk to other people in your town or in a nearby town or city. But suppose you wish to call Chicago, or New York, or San Francisco, or even London, are you compelled to ask the company for a different instrument, a bigger service and a special preparation for this broader, unexpected use of your telephone? You are not. You take the receiver down and just say, "Give me Chicago 41144," and you get it.

4. But when you apply for your electric service, your home is wired and you make application to the power company. The contractor installs a 30-amp. service entrance switch. The utility sets a 15-amp. meter, perhaps. Everything is lovely—until some day you and your wife decide to cook electrically. And then you find that though you can have plenty of gas for a water heater, or plenty of water for another bathroom or can talk to Florida through the same telephone you have put in to chatter round the town, when it comes to electricity all is very different. For the great electrical industry is not accustomed to have people ask suddenly to use more service than they expected. In fact, the great electrical industry hasn't been organized with any such idea in mind.

"And so in all America any large additional use of electric service is barred because the service arrangements and the meter, having no imagination of their own, have not expected it and are not ready. And if John Doe or Mrs. Mary Brady want to use an electric range they must call for a contractor and rewire their house, and put in heavier copper up to the range. For the electrical industry gives warning that it permits no man or woman to change his or her mind and cook by electricity unless he or she pays perhaps $40, or in some towns $90 or more, to change the wiring. It has never occurred to electrical men that the service entrance might be made ready in advance."

Better Standard

That's what the salesman said. And the general manager thought a

while and he said. "I guess you're right. I'd never thought of it before.'

And then the salesman said, "Why don't we put an end to this condition in this town by standardizing at least on a 60-amp. service entrance so when somebody wants to use a range, at least the service will be ready, and there will only be a very small expense to run a circuit to the kitchen?"

And the general manager agreed and they called a meeting of all the local contractors and the inspectors and everybody interested and before long there was established in that city a new ruling that has standardized the 60-amp. service capacity—ready to serve.

And filled with zeal from this experience, this salesman has been preaching this gospel in other cities and getting other groups together, and out of this work has come a movement. The idea has been planted in many minds and it looks as though in many cities they are going to tear down this old barrier to the increased use of electricity by standardizing on a minimum service capacity of three No. 6 wires and a 60-amp. service switch on all services in their jurisdiction. At the present time in Grand Rapids and Lansing, Mich., they now have rulings of this nature in effect. A letter which I received recently from a Grand Rapids electrical man said: "I want to add that our 60-amp. rule is working out fine and every one is satisfied."

But it has not been easy. In some sections there is the most determined opposition on the part of the power companies. It has never been done. It is not necessary. People are not using ranges. It will make house wiring more expensive. These and a dozen other reasons are thrown up. But none of them can stand against the cold logic that bids electrical industry remove these barriers that now prevent the greater use of electricity for cooking and for water heating.

It is about time that we exposed ourselves to the possibility that some day the Johns and Marys in these houses will desire and have the right to cook and heat their water electrically. Fore-thought and preparation are highly regarded in most instances. Must the electrical industry deny itself the opportunity to profit by this good old axiom in so many homes? Is our vaunted readiness to serve to be so easily confounded?

No. It is high time for us in the electrical industry to join this adequate service movement and begin automatically to provide our customers with an adequate service when a home is built or a building is wired. Then there won't be any more ranges reposing in the parlours.

—*Electrical World*

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

A meeting of the Executive Committee of this Association was held at the office of the Hydro-Electric Power Commission of Ontario, Toronto, at 2 o'clock on Thursday, September 6, 1928. The following members were present: Messrs. J.

G. Archibald, President, O. H. Scott, V. B. Coleman, J.E. B. Phelps, J. J. Heeg, R. J. Smith, A. W. J. Stewart, V. S. McIntyre, H. G. Hall, T. J. Hannigan and S. R. A. Clement.

It was moved by Mr. V. S. McIntyre and seconded by Mr. R. J. Smith, THAT the minutes of the last Executive meeting and of the Summer Convention be taken as published in the BULLETIN—*Carried.*

The suggestions by Mr. H. T. Gibbs that this Association join with the Canadian Electrical Association and the Canadian Electric Railways Association in a joint convention to be held at Ottawa next summer was discussed. It was moved by Mr. O. H. Scott and seconded by Mr. A. W. J. Stewart, THAT the matter of joint convention with the Canadian Electrical Association and the Canadian Electric Railways Association be left in the hands of the President, to be taken up with Mr. H. T. Gibbs.—*Carried.*

It was moved by Mr. V. S. McIntyre and seconded by Mr. O. H. Scott, THAT this Executive recommend to the Ontario Municipal Electrical Association the advisability of that Association taking up with the Hydro-Electric Power Commission of Ontario the desirability of using the Canadian National Exhibition as a means of placing the advantages of Hydro before the people of Ontario.—*Carried.*

Mr. A. W. J. Stewart presented suggestions in reference to the Winter Convention of this Association. That the most suitable dates available with the King Edward Hotel are January 23 and 24, 1929, provision being made for Convention luncheons on the two days and banquet on the evening of January 23rd, and arrangements for meeting rooms for the two associations. There was also suggested that this Association invite the Electric Club to have lunch with us on Wednesday, January 23rd.

It was moved by Mr. J. E. B. Phelps and seconded by Mr. V. B. Coleman, THAT the dates suggested in Mr. A. W. J. Stewart's report be accepted.—*Carried.*

It was moved by Mr. J. J. Heeg and seconded by Mr. V. S. McIntyre, THAT the other details of the report be adopted and that Mr. A. W. J. Stewart make the necessary arrangements.—*Carried.*

It was moved by Mr. V. S. McIntyre and seconded by Mr. O. H. Scott, THAT Mr. A. W. J. Stewart and Mr. T. J. Hannigan get together to arrange for banquet entertainment and speakers for the luncheons.—*Carried.*

The Secretary was instructed to write the Electric Club an invitation to attend the first luncheon.

The Papers Committee under Mr. O. H. Scott, Chairman, was instructed to arrange for papers for the Convention, there being three sessions, *viz.*, afternoon of January 23, morning and afternoon of January 24.

Mr. J. E. B. Phelps, Chairman of Merchandising Committee made a brief statement of matters in hand with that Committee.

Mr. V. S. McIntyre and Mr. T. J. Hannigan advised as to progress with the pension scheme.

There being no further business the meeting adjourned at 3.30 p.m.

Two Interesting Publications by the Commission

The Hydro-Electric Power Commission of Ontario has recently issued two interesting pamphlets, the first and smaller of the two is chiefly for visitors to the Commission's power plants at Niagara Falls; the second is of wider scope and is for the information of those who desire to obtain a general knowledge of the co-operative, municipal electrical undertaking administered by the Commission.

Niagara Power is a 32-page booklet of convenient size (4¾ x 7½ inches) to slip into the pocket or to send by post. It explains the power potentialities of the Niagara river and falls and describes in non-technical language the power plants owned by the co-operating municipalities of Ontario as operated on their behalf by the Hydro-Electric Power Commission. The pamphlet also contains a brief summary description of "Ontario's Unique Electrical Service" with special reference to those features, such as the cost of service, which have been the subject of interested enquiry by visitors to the power plants. This booklet is well illustrated with half-tone engravings, and space has been found in it for two sketch maps in colours, one of Niagara river from Lake Erie to Lake Ontario, and the other a more detailed map of the vicinity of the Falls and the Gorge. A page is devoted to the Illumination of the Falls, and another page to the Niagara Falls Park Commission. Two other pages are devoted to "A few facts respecting water power and its development" and are designed to convey to the non-technical but interested visitor to the great power plants an understanding of the principles practically applied in utilizing the flow of water to produce electricity. The pamphlet has a striking cover, and visitors to the power plants receiving a copy will have some thing which, by the information conveyed, will enhance the value of their visit.

The Hydro-Electric Power Commission of Ontario, Its Origin, Administration and Achievement is an octavo booklet (about 7 x 10 inches) containing 39 pages of text and 17 plates of half-tone engravings printed on coated paper and interleaved with the text. This publication presents in broad outline what has been accomplished by co-operating municipalities in the province of Ontario in the matter of supplying electrical energy to their citizens. The subject matter is divided into four main divisions dealing respectively with the "Origin of the Enterprise"; the "Administration of the Undertaking"; the "Achievements of the Commission"; and the "Power Developments." The Commission has had thousands of requests for information respecting its operations and this pamphlet has been prepared in order to place those specially interested in possession of the essential facts. This is a publication of rather a comprehensive character and consequently more discrimination is exercised in its distribution. Copies will be found on the shelves of the principal libraries.

Electrical Engineering

Electrical engineering is working revolution in all the affairs of mankind. It is squeezing the earth from an unwieldy mass of cotton into a compact bale; it is destroying our conceptions of time and space altogether. It is doing the work in this country of the 10,000,000 humans hauling away at the proverbial rope. It is creating all the time a world of luxury.

Electrical engineering has a fascination all its own because it is dealing with the Great Unknown. It is harnessing an unknown power. It is taking the Unseen and employing it for everyday use. It is going out into space and using the impermeable ether to carry its messages. It is challenging Chaos itself and turning it into Cosmos, as one of its distinguished engineers has put it. It is performing miracles which are no longer miracles because they soon become commonplaces, and those who work them make no claim to the miraculous.

Take Electricity out of the mechanical, practical affairs of life and where would society find itself? In a morass. Imagine what would happen to the world were electrical means of communication removed or suspended. And we would have to turn the clock back only half a century to do this—a tick in the dial of science.—From an editorial in the *Rocky Mountain News*, Denver.

Hydro News Items

Central Ontario System

Estimates are being prepared for a supply of 300 to 400 h.p. to the Consolidated Sand & Gravel Co., located at Fuller, Ont.

* * * *

Considerable extensions are being planned by the Canadian General Electric Co., at Peterboro which will will necessitate an increased supply of power from the Peterboro Public Utilities Commission.

* * * *

In view of the recent recommendations of the Central Ontario Power Association, the towns of Oshawa, Cobourg, Deseronto and Millbrook are now seriously considering the purchase of their local distribution systems from the Commission. Full information with regard to these properties is being prepared for the various municipalities concerned.

* * * *

Mr. Allan B. Moore is erecting a large printing establishment just outside the village of Pickering, taking from 20 to 30 h.p. It is probable that an extension of the Pickering rural lines will be made to serve this printing plant.

* * * *

Georgian Bay System

The success of Hydro service in the Beaumaris area of the Muskoka district in operation for the first time during the past summer season has resulted in stimulating great activity at Windermere and Rosseau for similar benefits. An investigation has been made and estimates are being prepared covering a station at Utterson on the Huntsville line, which will make provision for serving both of these villages, and the adjacent summer resort district, as well as the villages of Utterson and Port Sydney and the summer resort district in the vicinity of the Lake of Bays. Low voltage lines, probably at 8,000 volts will radiate from the proposed substation throughout the district to be served.

* * * *

The construction of rural lines in the Tara Rural Power District, including the townships of Derby, Arran, and Keppel is progressing. These rural lines constitute an extension to the original lines constructed in Derby townships last year and will serve a large number of farms, as well as the Village of Allenford. This work will be completed and the new line placed in operation about the end of October.

* * * *

Construction work at the new development at Tretheway Falls on the South Branch of the Muskoka River is progressing favorably. The construction schedule calls for completion by the end of next summer, which will result in an increase of 2,300 h.p., to the generating plant of the Georgian Bay System. The work is being performed by the H.E.P.C. Construction Department.

Niagara System

The Blenheim transforming station was recently increased in capacity. Three 250 kv-a., 26,400-4,000 volt outdoor type transformers were installed. The principal growth in load supplied from this district is in the Rural Power District in the territory adjacent to Blenheim.

* * * *

Tests were recently made by engineers of the Commission in connection with new waterworks pumps installed by the Town of Goderich. The installation consists of a domestic pump electrically driven by 1—100 horsepower motor, the pump having a capacity of 725 imperial gallons per minute against a 310 foot head, and in addition, two gasoline engine driven pumps for fire purposes, each being capable of delivering 1,000 imperial gallons per minute against a 510 foot head. The Sterling engines are six cylinder, 250 horsepower, running at 1,400 rev. per min.

* * * *

Mr. A. V. Manson, who for a number of years has been City Engineer in Stratford, has resigned that position to accept the post of General Manager of the Stratford Public Utilities Commission. The Utilities Commission handle the Gas and Water, as well as the Electric Department.

* * * *

A new 8000 volt line has recently been completed between Clinton and Bayfield. This line will be part of the system in the Clinton Rural Power District.

Arrangements are under way for the construction of a new sub-station in Scarboro Township. The station will have a capacity of approximately 4,500 kv-a. and will supply Scarboro Township, the Village of Agincourt, and the adjacent Rural Power Districts.

* * * *

The Stamford Township Hydro-Electric System's load has increased to such an extent that a 300 kv-a. transformer installed in the Fall of 1927 is now being replaced by a 1,500 kv-a. permanent unit, which will be inter-connected with the existing 900 kv-a. installation. The redesigning of the station was done by the Electrical Engineering Department and the work is being carried out under their supervision. It is hoped to have the station in operation before the end of October, delivery of the transformer being expected during the month of September.

* * * *

Nipissing System

The Commission is proceeding with the construction of an additional generating station at Elliott Chutes on the South River and this work is now progressing. The completion of this plant next year will give the Commission 1800 h.p., additional generating plant for the Nipissing System. The connecting transmission line between the existing Hanna Chute Development and that at Elliott Chutes has been completed and will be used to furnish construction power for the latter. An additional circuit has been constructed on the existing poles of the present transmission line from Powassan to

North Bay, thus giving the Commission two circuits from the generating plant to the load. A new substation is also being constructed at North Bay and changes made in the existing station, which will make an additional 750 kw. available for the City of North Bay. This new station and transmission circuit will be placed in operation this Fall.

The Timid Stenog

"Now, Miss Blogg," boomed Jasper M. Whurtle, President of the Whurtle Whirlwind Laundry Company, to his new Stenographer, "I want you to understand that when I dictate a letter I want it written as dictated, and not the way you think it should be. Understand?"

"Yes, sir," said Miss Blogg, meekly.

"I fired three Stenogs. for revising my letters, see?"

"Yes, sir."

"Alright—take a letter."

The next morning, Mr. O. J. Squizz of the Squizz Flexible Soap Company received the following:

"Mr. O. K. or A. or J. something (look it up,) Squizz, President of the Squizz what a name Flexible Soap Company, the gyps.,
Detroit, that's in Michigan, isn't it?"

Dear Mr. Squizz, hmmm;

Your a h—— of a business man. No, start over. He's a crook, but I can't insult him, or the bum'll sue me. The last shipment of soap you sent us was of inferior quality and I want you to understand, no scratch out I want you to understand. Ah, unless you can ship, furnish, no, furnish us with your regular soap, you needn't ship us no more period. or whatever the grammar is, and please pull down your skirt. This d—— cigar is out again; pardon me, and furthermore, where was I? Nice bob you have.

Paragraph.

The soap you sent us wasn't fit to wash the dishes, no make that dog, with comma, let alone the laundry comma, and we're sending it back period. Yours truly.

Read that over, no, never mind, I won't waste any more time on that egg. I'll look at the carbon to-morrow. Sign my name. We must go out to lunch soon, eh?"

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Inauguration of Gatineau Power

DELIVERY of power to the Commission by the Gatineau Power Company for use in the Niagara System was inaugurated on the afternoon of October 1st, 1928. This took the form of an official opening scheduled for 2.30 p.m. on that day. The actual ceremonies, however, were postponed for one hour out of respect for the late John R. Robinson, former Editor of the Toronto Evening Telegram, and to permit some of those participating in the opening to be present at his funeral.

The agreement made early in 1926 between the Commission and the Gatineau Power Company calls for the delivery of 230,000 to 260,000 horsepower to the Commission at the inter-provincial boundary. Commencing with October 1st, the Commission is required to take an initial block of 80,000 h.p. The construction of the transmission line and transformer station, was sufficiently completed by September 25, 1928, to permit tests being made under operating conditions.

A transmission line at 220,000 volts was built from the Power Company's plant at Paugan Falls on the Gatineau River in Quebec, a distance of approximately 230 miles; a transformer station was erected by the Commission at Leaside immediately north-east of the City of Toronto; and 110,000-volt connection was made to the system served from Niagara Falls, and 13,200-volt connection to Toronto.

It is of interest to note that practically all the equipment used is of Canadian manufacture and erected under the supervision of Canadian engineers.

The act of officially turning on the power was performed by the Honourable G. Howard Ferguson, Premier of the Province of Ontario. Mr. C. A. Magrath, Chairman, Hydro-Electric Power Commission of Ontario, acted as Chairman of the ceremonies and briefly outlined the

CONTENTS

Vol. XV **No. 10**

October, 1928

	Page
Inauguration of Gatineau Power	325
Progress in the Use of Hydro up to the end of 1927	327
Application of Hydro-Electric Power to Farm Work	340
Demonstration at Provincial Plowing Match	345
Canadian Electrical Code	349
Survey of Neon Signs	351
Prone Pressure Resuscitation	355
Housekeeping for Power Houses and Other Public Utilities	357
Hydro News Items	361

reasons for the construction of the plant.

One feature was the exchange of messages of greeting and felicitation between Premier Ferguson and Premier Taschereau of Quebec over the teletypewriter system by which all operating messages between the Paugan Falls plant and Leaside station will be transmitted. The message from Premier Taschereau read—

> "It is of the utmost significance to the development of industry, not only in Ontario and Quebec, but in the entire Dominion. I extend my greetings and congratulations and those of the people of Quebec to all those who have taken part in the launching of the project."

Premier Ferguson wired in reply—

> "This enterprise makes the electrical energy generated in the one Province available to meet the immediate and pressing needs of the other. The event is a striking illustration of the mutual advantage of co-operation between these two great communities. On the one hand the market Ontario offers for power has faciliated a great development and an investment of capital in the Province of Quebec. To both Provinces it is, I am sure, extremely satisfactory to realize that the natural resources of Canada are by this arrangement being utilized to build up Canadian industry. So long as Canadians stand side by side in upholding Canadian interests we can face the future with confidence and with the assurance that we are doing our part to advance the common welfare of our people."

The connection of the Gatineau line with the Niagara system was symbolized by an electric sign with the words "Niagara-Leaside-Gatineau." The words, "Niagara" and "Leaside" being illuminated signified the station to be connected with Niagara. When Premier Ferguson closed the switch, the word "Gatineau" also became lighted, signifying the connection of the Gatineau line with the station.

In his address, Mr. Ferguson foretold an even greater development of Hydro service in consequence of the Gatineau-Toronto project and commented on the remarkable feat of Hydro in reaching a point in 20 years where it distributed over one million horse-power to 500,000 people. He spoke of the difficulties and delays in reference to the development of powers on the Ottawa and St. Lawrence Rivers and of the good

fortune of the Commission in being able to get power from the Gatineau to avert shortage by the limitation by the International Treaty of the generating capacity of the Niagara plants.

Others who were present and addressed the large gathering of Hydro, civic and provincial representatives, and representatives of the various contractors, were—Attorney-General W. H. Price, Commissioner C. A. Maguire, H.E.P.C. of Ontario, Mr. Geo. Wright of the Toronto-Hydro Commission, Chairman Guy Long of the Hamilton-Hydro Commission and Mr. T. J. Hannigan of Guelph, Secretary, Ontario Municipal Electrical Association. A number of speakers paid tribute to the late Chairman of the Commission, Sir Adam Beck, the Prime Minister declaring in this respect that "For years to come, memorials of stone and brass would continue to be erected to the late Sir Adam Beck, but the most lasting monument and that by which he would be remembered would be the actual presence of Hydro power in the homes of the common people."

The ceremonies were completed by a short address of reply by Chairman Magrath.

Many letters, telegrams and cablegrams were received by the Commission, congratulating it and its staff on the successful completion of the project, the first transmission line at 220,000 volts in the empire and the longest line at that voltage in the world.

Progress in the Use of Hydro up to the end of 1927

By G. J. Mickler, B.A.Sc., Sales Dept., H.E.P.C. of Ont.

LOCKED in the pages of the Annual Report issued by the Hydro-Electric Power Commission of Ontario each year is much very valuable information on the progress that has been made since the first power was turned on in 1910 up to the present time in the use of Hydro power for various purposes. On account of the mass of information presented in the Annual Report it is difficult for the ordinary layman to locate and interpret the data which concern him most, namely, the growth in the use of power and the effect of increased use on the cost per unit and the cost per consumer per month.

For the past two years an attempt has been made by the writer to unlock these pages and throw some light on the situation by presenting in table and graphic form what has actually taken place in the five principal branches of the service, namely, Domestic Lighting, Commercial Lighting, Commercial Power, Municipal Power and Street Lighting, and THE BULLETINS of January, 1927, and November, 1927, presented a review of the progress made up to the end of 1925 and 1926 respectively, insofar as

the published data and other information available would permit.

The picture was incomplete, however, due to the fact that the data in connection with the Central Ontario System operated by the Hydro-Electric Power Commission and large industrial consumers served directly by the Hydro-Electric Power Commission were not included in the graphs and tables submitted, and while the results of operation on the Central Ontario System would not have affected the general results to any marked degree, the omission of the figures for the large industrial users of power did affect results to a considerable extent, so much so, that it has been deemed wise to go back for a period of three years and revise the figures in previous tables to incorporate these data.

The result of incorporating the data on large industrial users has been to reduce the cost of commercial power to approximately 0.6c. per kilowatt hour over all, and the average cost of power for all services to approximately 1c. per kilowatt hour.

As in the past the tables and graphs presented were prepared to show—first, the progress in the rate of current consumption of domestic and commercial lighting customers—second, the gradual lowering of the average cost per kilowatt hour for current sold to these customers; third, the average monthly bill paid by each customer for these services; fourth, the cost per kilowatt hour of power for commercial and municipal power purposes; fifth, the average cost per kilowatt hour of power for street lighting purposes; sixth, a summary showing the average cost per kilowatt hour for services during the years 1925, 1926 and 1927.

The general results of these tables show that the cost of power to domestic and commercial users for Ontario is still on the decrease, while the rate of consumption is increasing very rapidly. They also show that the cost of power for municipal purposes, that is, for waterworks, sewerage works, street railways and other municipal services, is less per kilowatt hour than that for ordinary industrial uses for domestic and commercial lighting and for street lighting, proving conclusively that rates for domestic and commercial service are not lowered at the expense of municipal service. They also show that the cost of power per kilowatt hour for street lighting purposes is lower than that for domestic or commercial lighting when placed on an equal basis.

In Table No. I we have the results of operation for domestic service in 24 cities of over 10,000 population. During the 14 years covered by this table it will be seen that the annual revenue is approximately 10 times what it was in 1914; the annual kilowatt hours consumed are approximately 30 times what they were in 1914, the number of consumers served is 5 times what it was in 1914; the average cost per kilowatt hour is ⅓ of that of 1914; the average monthly bill is but 80 per cent. higher than it was in 1914, in spite of the fact that the average monthly consumption is almost 6 times what it was at the beginning.

In Table No. II covering towns of 2,000 to 10,000 population, we have

TABLE No. I

Data for Cities over 10,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	12	$ 614,925.00	12,646,400	55,597	4.86c.	$1.06	21.8
1917	19	1,063,264.00	36,693,100	107,248	2.89c.	0.88	30.5
1920	21	1,926,924.00	84,328,000	154,186	2.29c.	1.11	48.4
1923	21	3,772,416.00	206,266,200	223,028	1.83c.	1.53	83.5
1926	21	5,374,069.00	324,290,285	255,109	1.66c.	1.80	108.0
1927	24	6,086,753.11	371,945,485	276,632	1.63c.	1.87	114.4

TABLE No. II

Data for Towns over 2,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	19	$ 90,330.00	1,414,500	7,410	6.38c.	$1.11	17.4
1917	27	180,375.00	3,824,600	15,731	4.71c.	1.01	21.4
1920	36	353,915.00	10,053,100	24,041	3.50c.	1.26	36.0
1923	43	651,499.00	25,411,300	34,135	2.56c.	1.57	60.1
1926	48	1,037,016.00	50,487,035	47,873	2.05c.	1.84	89.6
1927	55	1,325,096.89	62,105,723	56,813	2.13c.	1.99	92.9

TABLE No. III.

Data for Villages under 2,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	18	$ 24,913.00	291,000	1,859	8.55c.	$1.10	13.1
1917	77	97,516.00	1,412,500	8,334	6.90c.	0.96	14.0
1920	109	233,819.00	3,829,900	15,665	6.00c.	1.29	21.2
1923	142	531,505.00	11,249,100	29,689	4.72c.	1.59	33.7
1926	174	942,309.00	29,945,632	46,900	3.15c.	1.71	54.4
1927	188	1,095,340.79	35,900,482	52,088	3.05c.	1.81	59.5

an increase of from 19 to 55 municipalities, an annual revenue in 1927 of approximately 15 times what it was in 1914, a consumption of over 40 times what it was in 1914, and a growth in consumers of 8 times what it was in 1914; cost per kilowatt hour of ⅓, the same as applies to cities, and an increase in the municipal bill of about 80 per cent., in spite of an average monthly consumption increase of over 500 per cent.

In Table No. III for villages under 2,000 population, we have an increase in 1927 in revenue of approximately 40 times what it was in 1914; the consumption in kilowatt hours 120 times what it was in 1914, the number of consumers 29 times what it was in 1914, the average cost per kilowatt hour about 35 per cent. of what it was in 1914. The average monthly bill is up less than 80 per cent. in the face of an average monthly consumption 4½ times what it was in 1914.

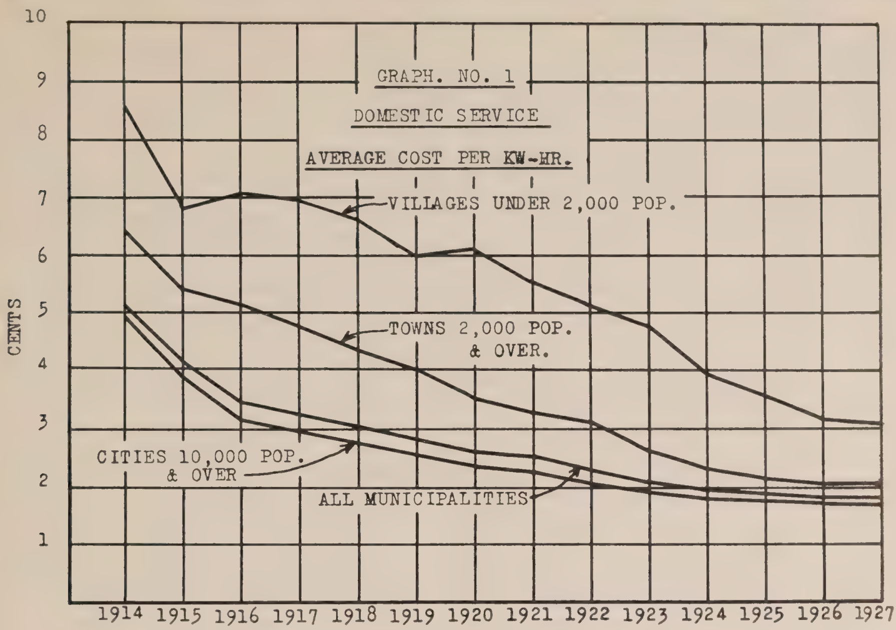
Table No. IV. summarizes the results of Tables I, II and III, and shows the following results: An annual revenue in 1927 nearly 12 times what it was in 1914, a consumption over 30 times what it was in 1914 and consumers over 5 times as numerous. The average cost per kilowatt hour is 36 per cent. of what it was in 1914, and the average monthly bill is up less than 80 per cent. of what it was in 1914, while the average consumption is 5 times that of 1914.

Let us look at the results during the past year. We find that there has been a decrease in the average cost per kilowatt hour, but a slight increase in the average monthly bill due to the increase in the average monthly consumption, which has gone up over 5 kilowatt hours per consumer.

An interesting feature of this report lies in the fact that we have in Ontario an average yearly consumption per domestic consumer of 1,242 kilowatt hours. This covers the consumers in the cities, towns and villages from one end of the Province to the other, and we know that in many other cases where data is published the domestic consumption over a wide area is only a small fraction of this figure.

TABLE No. IV
DATA FOR ALL MUNICIPALITIES
DOMESTIC SERVICE

Year	No. of Municipalities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost perKw-hr.	Average Monthly Bill	Average Monthly Consumption Kw-hr.
1914	49	$ 730,168.00	14,359,100	64,866	5.08c.	$1.06	21.0
1917	123	1,340,855.00	41,930,200	131,313	3.20c.	0.91	28.6
1920	166	2,514,658.00	98,211,000	193,892	2.56c.	1.15	44.6
1923	206	4,955,420.00	242,92,600	286,858	2.04c.	1.54	75.7
1926	243	7,353,394.00	404,722,959	349,882	1.81c.	1.79	98.4
1927	267	8,497,190.79	469,851,690	387,573	1.80c.	1.87	103.5

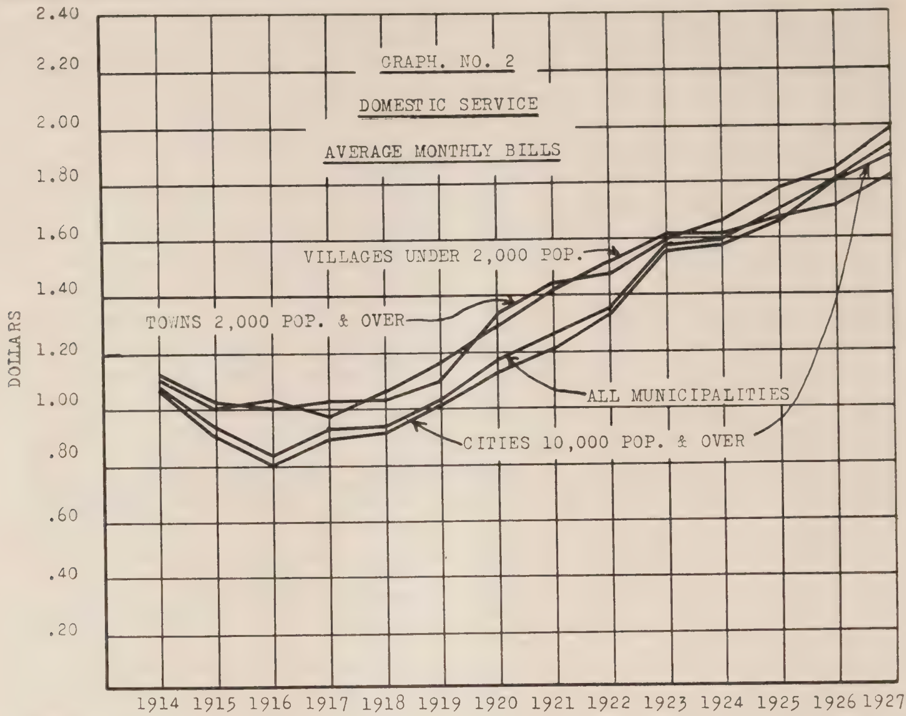


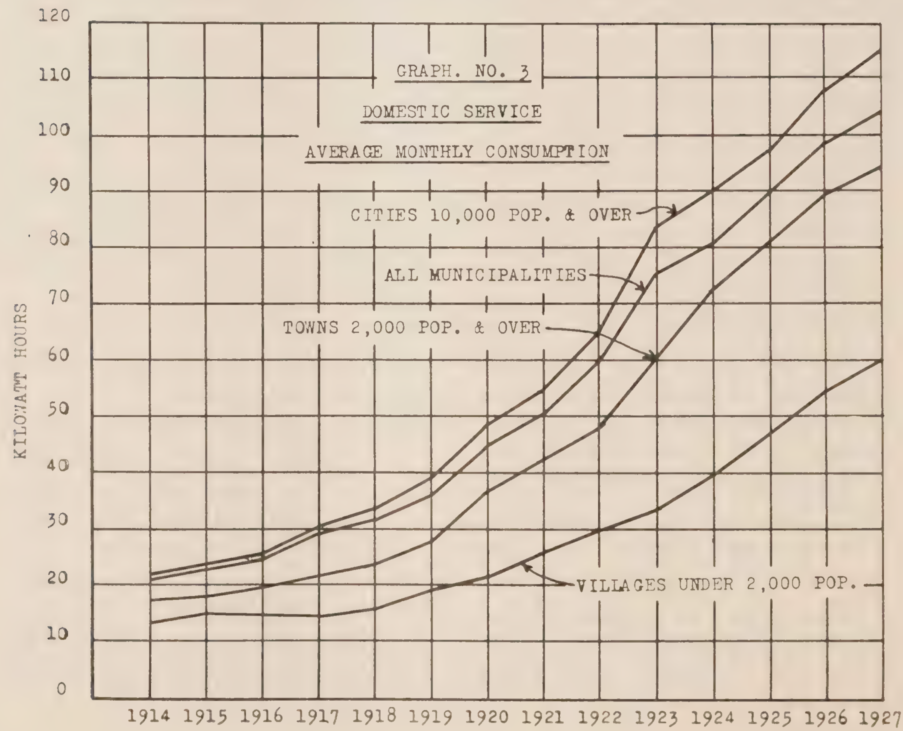
It is estimated that in the United States among privately owned Utilities the average consumption of domestic users is less than 365 kilowatt hours per year. In some localities there may be and undoubtedly are higher rates of consumption, just as there are in many localities in Ontario.

To refer to the Annual Report of the Hydro-Electric Power Commission for 1927 we find the following remarkable rates of consumption: Niagara Falls, 2,568 kilowatt hours per domestic consumer per year, Ottawa 2,460, Windsor 2,268, Walkerville, 2,904 kilowatt hours per year, Waterloo 1,740 kilowatt hours per year, Tavistock 1,224 kilowatt hours. These are just some of the high points in the published data. There are many more striking examples of the lavish use which is being made of electricity for domestic purposes by the average consumer. One other point that may be worthy of note in connection with this table is the growth in consumption between 1926 and 1927, 65,000,000 kilowatt hours, or over 15 per cent. It gives us some idea of the rate at which additional power must be found to supply the ordinary demand of domestic users.

A graphical representation of the foregoing tables is provided in the following graphs, which were plotted from the results obtained each year since 1914, and they present an interesting picture of the results during the past 14 years.

Graph No. 1 shows the average cost per kilowatt hour in 4 curves, one each for cities, towns, villages, and all municipalities combined. This graph shows a steady decline in the average cost per kilowatt hour, although the curves are flattening out during the last two or three years. The cost of power cannot get much lower than it is at the present time.


GRAPH. NO. 2
DOMESTIC SERVICE
AVERAGE MONTHLY BILLS
VILLAGES UNDER 2,000 POP.
TOWNS 2,000 POP. & OVER
ALL MUNICIPALITIES
CITIES 10,000 POP. & OVER
DOLLARS
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
.20
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927


GRAPH. NO. 3
DOMESTIC SERVICE
AVERAGE MONTHLY CONSUMPTION
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS 2,000 POP. & OVER
VILLAGES UNDER 2,000 POP.
KILOWATT HOURS
120
110
100
90
80
70
60
50
40
30
20
10
0
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

Graph No. 2 pictures the performance in the amount of average monthly bills in four different curves, representing the same classes as Graph No. 1. These curves show an almost uniform growth in the monthly bill, due to an almost uniform growth in the average monthly consumption.

Graph No. 3 shows the average monthly consumption per consumer and one can see from the curves the steady increase in the use of power in villages, towns and cities. This growth in consumption has been brought about through the steady demand of consumers for large current consuming devices without any outside aggression on the part of manufacturers or distributors. Should a Provincial Campaign be inaugurated to promote a more general use of ranges, water heaters, grates, ironing machines, refrigerators, etc., it is hard to conjecture what these curves would look like. Let it be remembered that the latest statistics available show that only 21.3 per cent. Hydro consumers use electric ranges, 8.2 per cent. use electric washing machines, 3.4 per cent. use electric grates, .6 per cent. use electric ironers, 2.9 per cent. use electric refrigerators. There is no reason why some at least of these appliances should not have close to 100 per cent. saturation.

Graph No. 4 shows the growth of use among domestic consumers in six typical municipalities.

In Table Nos. V, VI, VII and VIII the information in connection with Commercial Lighting service has been handled in the same way as that of Domestic Lighting service, and the summary table No. VIII shows that

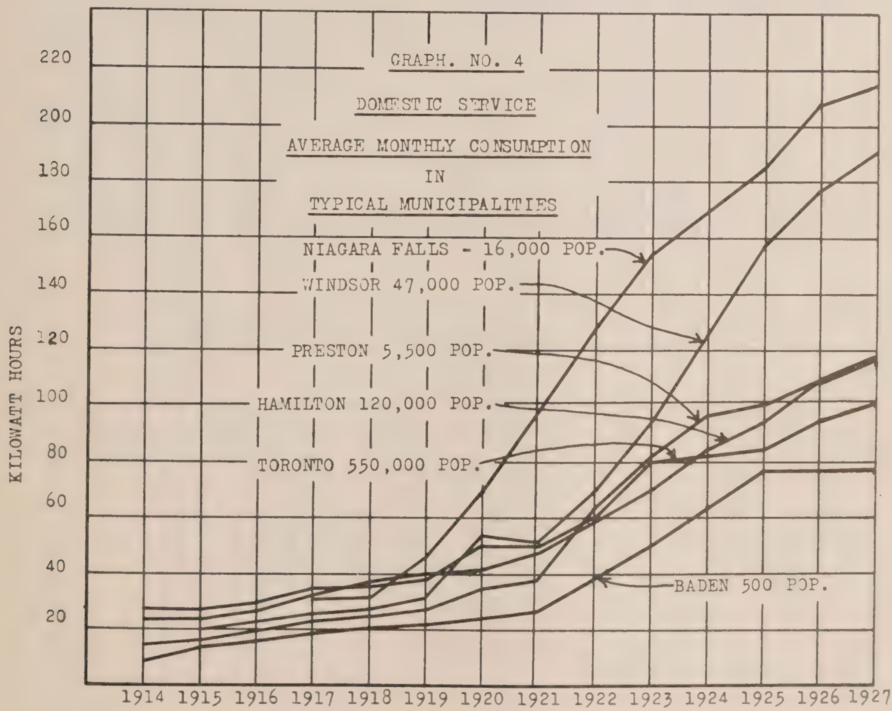


TABLE No. V

Data for Cities over 10,000 Population
Commercial Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost perKw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	12	$ 536,350.00	14,048,500	12,439	3.80c.	$3.94	103.7
1917	19	642,989.00	27,479,800	19,573	2.34c.	2.96	126.6
1920	21	1,103,599.00	50,358,000	25,505	2.19c.	3.77	172.0
1923	21	2,043,197.00	91,146,500	32,016	2.25c.	5.56	246.9
1926	21	3,393,186.00	147,581,714	40,675	2.30c.	7.08	308.0
1927	24	3,844,501.17	169,213,258	43,702	2.27c.	7.49	329.2

TABLE No. VI

Data for Towns over 2,000 Population
Commercial Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost perKw-hr.	Average Monthly Bill	Average Monthly Consump tion Kw-hr.
1914	17	$ 71,457.00	1,362,000	2,393	5.25c.	$2.61	49.8
1917	27	134,730.00	3,100,600	4,107	4.35c.	2.76	63.5
1920	36	221,867.00	6,179,400	5,736	3.59c.	3.30	91.8
1923	43	315,530.00	9,598,000	7,086	3.29c.	3.76	114.3
1926	48	430,467.00	15,709,616	8,310	2.74c.	4.31	160.0
1927	56	560,479.40	20,372,460	10,054	2.79c.	4.79	172.3

TABLE No. VII

Data for Villages under 2,000 Population
Commercial Service

Year	No. of Munici-palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost perKw-hr.	Average Monthly Bill	Monthly Consump-tion kw-hr.
1914	14	$ 16,974.00	259,200	825	6.55c.	$1.74	26.6
1917	77	82,756.00	1,403,100	3,773	5.86c.	1.87	31.7
1920	109	152,497.00	2,799,500	5,255	5.89c.	2.45	45.0
1923	142	254,530.00	4,738,100	7,281	4.80c.	2.96	55.1
1926	173	352,942.00	8,505,684	9,459	4.15c.	3.22	77.7
1927	188	418,800.80	11,020,419	10,283	3.80c.	3.50	91.9

TABLE No. VIII

DATA FOR ALL MUNICIPALITIES

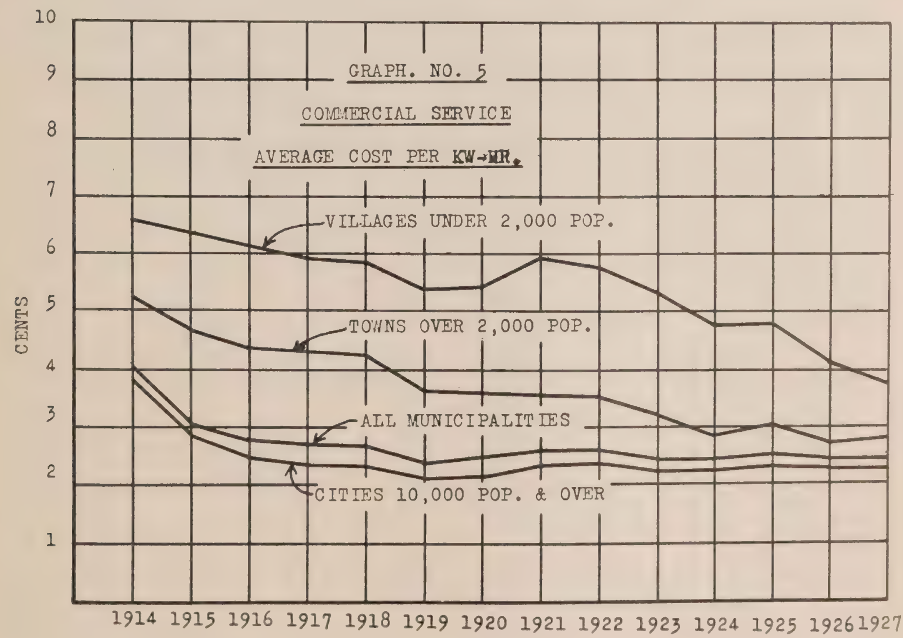
COMMERCIAL SERVICE

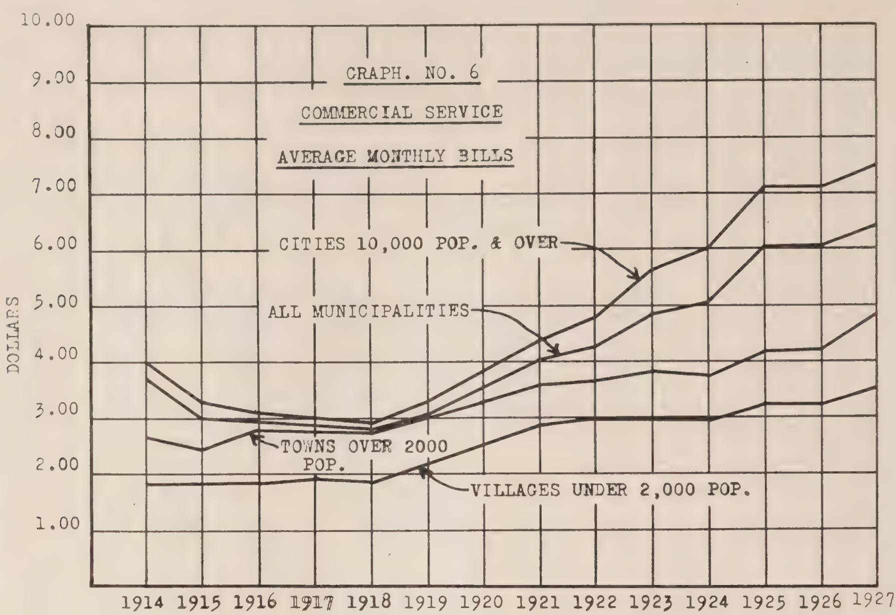
Year	No. of Munici- palities	Annual Revenue	Kw-hr. Consumed	Number of Consumers	Average Cost perKw-hr.	Average Monthly Bill	Average Monthly Consump- tion Kw-hr.
1914	43	$ 624,781.00	15,669,700	15,657	4.00c.	$3.63	90.8
1917	123	860,475.00	31,983,500	27,453	2.69c.	2.77	103.1
1920	166	1,477,963.00	59,336,900	36,496	2.50c.	3.51	140.0
1923	206	2,613,257.00	105,482,600	46,383	2.46c.	4.80	195.6
1926	242	4,176,595.00	171,797,014	58,444	2.43c.	6.08	250.0
1927	268	4,823,781.37	200,606,137	64,039	2.40c.	6.39	266.7

the annual revenue has increased approximately 8 times during the 14 year period; the consumption has increased about 13 times; the number of consumers about 4 times. The average cost per kilowatt hour is 60 per cent. of what it was in 1914. The average monthly bill is less than twice what it was in 1914, and the average consumption is almost 3 times what it was originally.

The results of these tables are further shown in Graphs Nos. 5, 6 and 7.

In Table No. IX are shown the results pertaining to the Commercial Power service, including customers served by the municipalities and




GRAPH. NO. 6
COMMERCIAL SERVICE
AVERAGE MONTHLY BILLS
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS OVER 2000 POP.
VILLAGES UNDER 2,000 POP.
DOLLARS
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

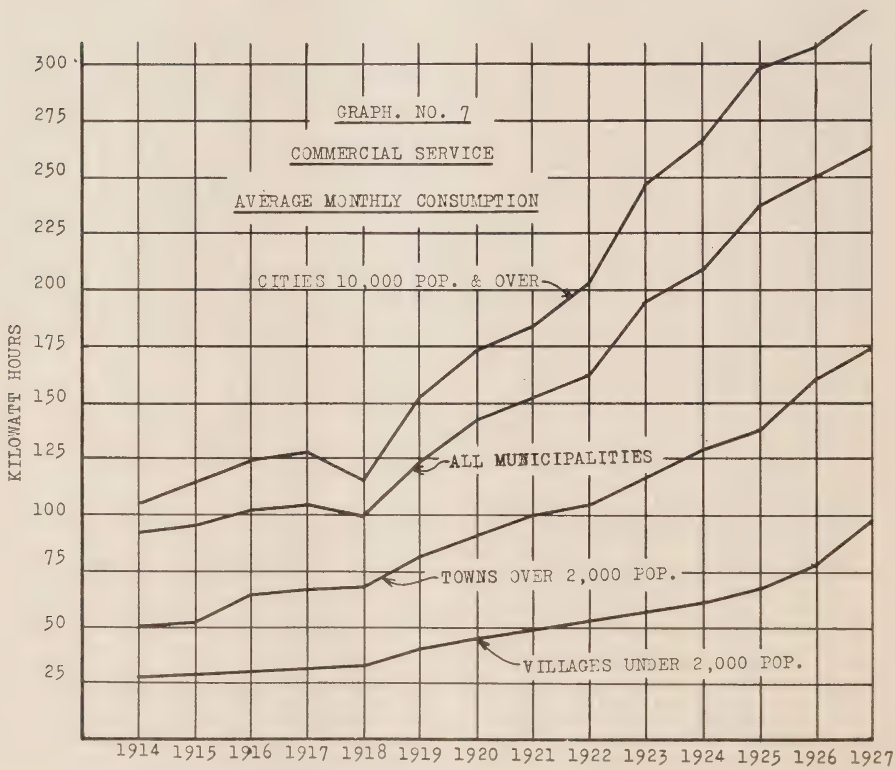

GRAPH. NO. 7
COMMERCIAL SERVICE
AVERAGE MONTHLY CONSUMPTION
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS OVER 2,000 POP.
VILLAGES UNDER 2,000 POP.
KILOWATT HOURS
300
275
250
225
200
175
150
125
100
75
50
25
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927

TABLE No. IX

DATA FOR ALL MUNICIPALITIES AND ALL PRIVATE POWER CONSUMERS OF THE H. E. P. C.

COMMERCIAL POWER SERVICE

Year	Number of Munici-palities	Number of Private Companies	Revenue	Kilowatt Hours	Average Cost per Kw-hr.
1925	161	75	$ 9,896,881.98	1,634,409,666	0.61c.
1926	216	80	11,192,925.57	1,879,029,286	0.60c.
1927	245	78	12,064,818.02	1,933,491,298	0.60c.

Companies supplied direct by the Hydro-Electric Power Commission.

In so far as the commercial power consumers in the municipalities are concerned, the data includes practically every power consumer in every Hydro municipality in the Province with very few exceptions, these latter being so small as to have no effect whatever on the averages. Insofar as the private industrial consumers served directly by the Hydro-Electric Power Commission are concerned, as explained previously in this article, we have gone back over a period of three years to arrive at the kilowatt hours consumed by these customers and the revenue received therefrom to incorporate in previous tables, as well as in the tables for 1927, the effect of these consumers on the general results.

In a great many cases the kilowatt hours were available; in some cases, however, the kilowatt hours had to be developed from chart readings on a load factor basis, and it is felt that the consumptions thus arrived at closely approximate the actual current consumed by the customers involved. The data for all private Companies served by the Hydro-Electric Power Commission or municipal systems are included in the tables. In order to make these figures comparative, it was necessary to include data for 1925, 1926 and 1927, and to revise the tables of these years accordingly, and as stated above Table No. IX shows the result of this operation.

From these figures it will be seen that the average cost of power for industrial purposes for 1925 is 0.61c. per kilowatt hour; the average cost in 1926 is 0.60c. per kilowatt hour, and the average cost in 1927 is 0.60c. per kilowatt hour.

Table No. X shows the results for 3 years in connection with Municipal Power service. This table covers practically every municipal power service, including waterworks, street railway services, and others of a municipal nature, and from this table you can see that the average cost per kilowatt hour to the municipalities during 1927 was 1c. per kilowatt hour.

Table No. XI shows the data for Street Lighting service for the three years 1925, 1926 and 1927. As in previous years, in arriving at the consumption for street lighting purposes, the installed capacity of the street lamps in use in the various municipalities was taken and this multiplied by 4,100 hours as an

TABLE No. X

DATA FOR ALL MUNICIPALITIES
MUNICIPAL POWER SERVICE

Year	Number of Municipalities	Revenue	Kilowatt Hours	Average Cost per Kw-hr.
1925	27	$1,683,896.00	160,031,150	1.06c.
1926	84	1,895,607.66	177,362,002	1.06c.
1927	85	1,859,787.79	186,247,165	1.00c.

assumed burning period. This corresponds very closely to the number of burning hours to which the street lighting service is subjected in the majority of municipalities. In 1927 the average cost of power for street lighting purpose is shown as 2.37c., which may seem high in comparison to other services, but here again let us explain that the cost of street lighting service is necessarily higher than that of other services on account of the fact that the rates charged by the municipalities for street lighting include in addition to the costs for other services, such as domestic and commercial lighting power, the cost of lamp renewals, maintenance of special street lighting equipment, interest and sinking fund on the capital cost of this special equipment and depreciation thereon. The amount involved in the cost of lamp renewals, maintenance and special equipment interest, sinking fund and depreciation is approximately $450,000.00, so that in making a comparison between the cost of street lighting service and that of other services this amount would have to be deducted from the revenue received, making the cost of street lighting service approximately $1,109,965.00 or approximately 1.7c.

Table No. XII constitutes a summary of the data for all services. From this table it will be seen that the average cost of power to all customers combined for 1927 is 1.01c. per kilowatt hour. This table also shows that between the years 1925 and 1927 there is an increase in consumption of 505,547,124 kilowatt hours, or roughly, 25 per cent. another indication of the trend of use of Hydro power by consumers in Ontario.

There are many other conclusions which may be drawn from the tables and graphs presented, but space and

TABLE No XI

DATA FOR ALL MUNICIPALITIES
STREET LIGHTING SERVICE

Year	Number of Munici-palities	Wattage of Street Lamps in Use.	Assumed Annual Burning Hours	Kilowatt Hours	Revenue	Average Cost per Kw-hr.
1925	244	15,100,000	4100	61,910,000	$1,414,382.00	2.28c.
1926	244	15,114,000	4100	61,967,000	1,457,687.00	2.35c.
1927	266	16,003,305	4100	65,613,550	1,559,965.10	2.37c.

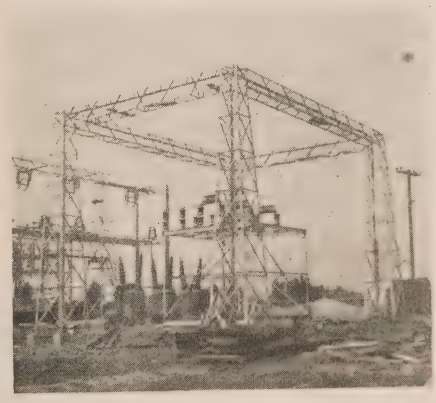
TABLE XII

Total Data of all Services for the Past Three Years

Service	1925 Kilowatt Hours	1925 Revenue	1925 Avg. Cost Kw-hr.	1926 Kilowatt Hours	1926 Revenue	1926 Avg. Cost Kw-hr.	1927 Kilowatt Hours	1927 Revenue	1927 Avg. Cost Kw-hr.
Domestic..........	342,356,700	$6,414,134	1.85c	404,722,959	$7,353,394	1.81c	469,851,690	$8,497,191	1.80c
Commercial........	151,555,200	3,856,946	2.54c	171,797,014	4,176,595	2.43c	200,606,137	4,823,782	2.40c
Commercial Power..	1,634,409,666	9,896,882	0.61c	1,879,029,286	11,192,926	0.60c	1,933,491,298	12,064,818	0.60c
Municipal Power....	160,031,150	1,683,896	1.06c	177,362,002	1,895,608	1.06c	186,247,165	1,859,788	1.00c
Street Lighting......	61,910,000	1,414,382	2.28c	61,967,000	1,457,687	2.35c	65.613,550	1,559,965	2.37c
Total..........	2,350,262,716	23,266,240	0.99c	2,694,878,261	26,076,210	0.97c	2,855,809,840	28,805,544	1.01c

time will not permit of further treatment of these conclusions in this article. Suffice it to say that Hydro power is being supplied to the consumers in Ontario at not only a remarkably low rate, but the rate seems to be becoming less as time goes on, and it will be interesting to follow the progress of these tables and charts during the next decade.

NOTE: In all of the preceding Tables the figures showing kilowatt hours represent the current sold to consumers of Hydro either Municipal or Provincial at the consumers' meters and the cost per kilowatt hour as shown represents the cost of generation, transmission, transformation and distribution of current to the ultimate customers located in the various municipalities. In some cases the point of distribution is over 250 miles from the generating centre and the distances from generating stations to points of distribution vary all the way up to this distance. (250 miles).



Application of Hydro-Electric Power to Farm Work

Article No. 16

DURING the past, this series of articles has been devoted to the many applications of Hydro-Electric Power as made use of by farmers in Ontario, being based on information gathered by the Commission. During the spring "The Farmer's Advocate" visited a number of farms in the vicinity of London, the story of whose findings as published we are taking this opportunity of reproducing.

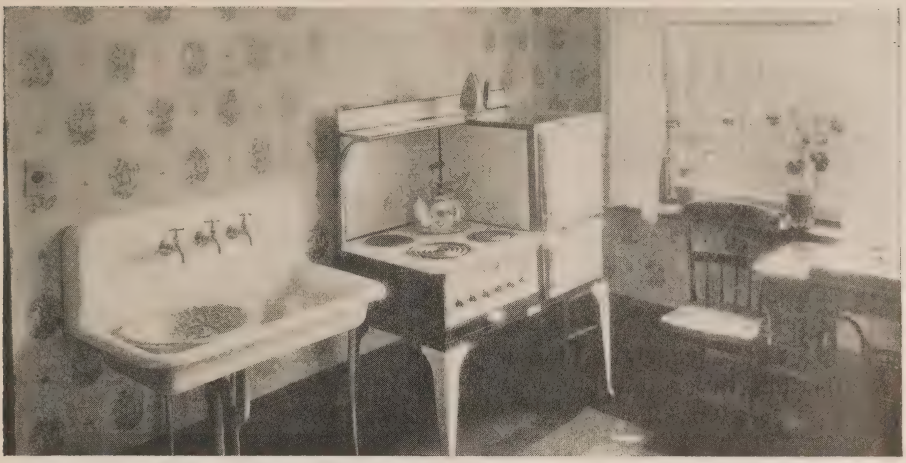
Hydro is a significant and powerful word. To rural folk, at one time, it meant little more than gigantic engineering achievements, huge dams and concrete structures on the rivers, and the expenditure of enormous sums of money.

It means more to-day. Women on the sideroads and concessions are curling their hair and sweeping their floors with this mysterious thing called Hydro, that in some miraculous fashion comes over wires hundreds of miles from strategic points where science and engineering skill have harnessed the falling water and transmuted it into a faithful, useful servant of mankind.

From the same inert looking wires that light the homes and perform the little household tasks men draw power for grinding, milking, separating and a dozen other jobs about the barn and buildings. Surely Hydro is beginning to mean something to farm folk.

In the London Rural Hydro Power District there are 1,350 subscribers or users of Hydro. This district embraces Westminster and London townships. A little survey was made in Westminster Township recently by an Editor of "The Farmer's Advocate," and following are the uses to which we found Hydro applied in farm homes: Lighting, cooking, heating, washing, ironing, toasting bread, hair curling, vacuum cleaning, refrigeration, pumping water under pressure, operating batteryless radios and charging radio batteries.

Outside the home we found Hydro put to these uses: Grinding, milking, separating, milk cooling, washing milk bottles, pumping water, cutting



A farm kitchen with electric range and water supply from an automatically pumped water system.

corn and fodder, cleaning grain for seed, running a saw, running emery wheels, charging car batteries and filling automobile tires.

There are 25 separate and distinct services to which Hydro is applied, and we fear the whole field has not yet been covered. Only those uses have been listed that were observed in a partial survey of one township. Other rural Hydro users can probably add to the number. "The Farmer's Advocate" will be grateful for any additions to the list.

Rural Hydro is installed by the Commission according to a definite classification. Farms of 50 acres or less usually come into Class 2B. The next is Class 3 or light farm service, which supplies power for miscellaneous small equipment and for single-phase motors not exceeding 3 horse-power. Class 4 is a medium farm service with single-phase motors up to 5 horse-power, and Class 5 is similar, except that it will meet the three-phase motor demand up to 5 horse-power. Beyond that are Class 6 and 7 for heavy farm service and special farm service; and beyond that again are contracts for syndicate outfits.

The farm of Lt.-Col. R. McEwen & Sons is serviced on the five horse power basis. Hydro is used there for lighting, washing, ironing, churning, auxiliary heating, and to operate a compression water system. There are three outlets in the barn and buildings for a five horse-power motor which is used for cutting fodder, pulping roots, sawing and running the emery wheel. The barns and out-buildings, of course, are electrically lighted. The wiring and installation cost around $225. The net service charge is $2.79 per month, and the last four quarterly net bills have been $12.58, $15.59, $17.62 and $16.96, or a total bill for the year of $62.75. Deducting the annual service charge of $33.48 it is apparent that the bill for actual power used throughout the year was $28.27. Colonel McEwen himself stated,

"The actual cost of the power is trifling."

"The rates quoted in a rural power district," writes F. A. Gaby, the Chief Engineer, "are determined upon the same basis as the Commission determines the rates for city or town service, namely, at cost adjusted annually. The effect of the provincial grant-in-aid towards the capital cost of primary lines and secondary equipment in reducing the fixed charges due to capital invested is taken into consideration.

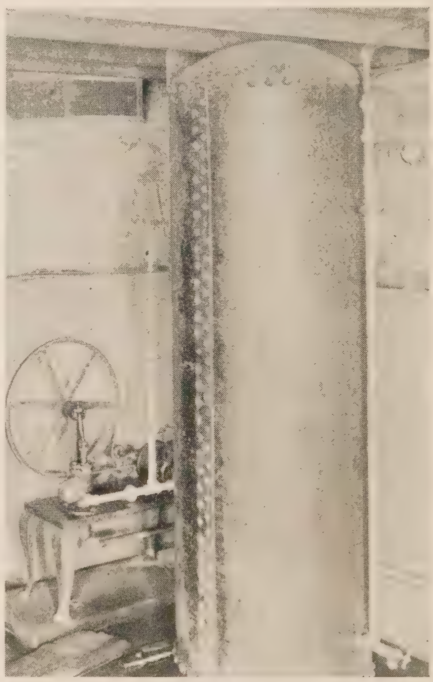
"The rates may be said to consist of two parts: First, a service charge which is designed to cover the annual fixed charges and the operating cost of the distribution system in the rural power district; and second, the power charge which is based on the cost of power at the distribution centre from which the rural lines originate."

This latter charge is in the form of a charge per kilowatt-hour for a definite number of hours use per month of the consumers class demand rating; and a follow up kilowatt-hour charge with a maximum of 2 cents.

The service charge is really a payment on the cost of the line construction and equipment. It is easy to see, therefore, how these costs may be reduced by having as many consumers as possible on the one line. Those who have had Hydro for several years have received substantial rebates after more consumers have come on the line.

This explanation of charges is made at this point so the reference made in this article to the costs of Hydro will be more intelligible.

One of the most interesting installations observed in the survey made was that on the farm of W. J. Nixon. A milk route originates here, and naturally there is considerable dairy equipment to be operated. Hydro is used in the home for lighting, cooking, operating the vacuum cleaner, clothes-washer, electric iron and toaster. In the basement is a compression water system which is operated automatically with an electric motor. A large refrigeration unit is operated by another motor and from a small one-quarter horse-power motor a milk cooler is run. The cooling process on this piece of equipment can be made drastic enough to freeze the milk so it hangs in icicles from the bottom of the cooler. Milk bottles are washed,



An automatic water system with storage tank, The range of pressure is from 20 to 40 lbs.

the automobile batteries are charged, from the Hydro, and the tires are filled with air taken from the water compression system. Altogether there are six electric motors around the place, one on the vacuum cleaner, one on the washing machine, one to operate the refrigerator unit, another the compression water system; there is a ¼ horse-power motor on themilk cooler, and a 3 horse-power motor in the barn. The latter motor is used largely for cutting up fodder. The last bill paid, which was on May 7 and for a period of three months, amounted to $25.46 net; the quarterly service charge was $8.85. This installation is classified as Class 3.

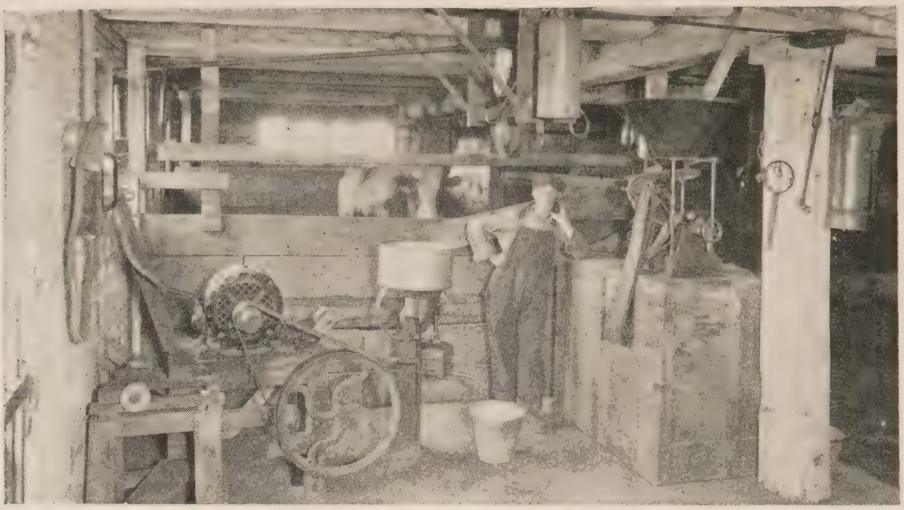
As an example of a real light farm service we might describe the installation at the home of Neil D. Munro. Here Hydro is used for lighting the house and barn, operating a washing machine and electric iron, and for charging the radio batteries. The cost of wiring the buildings was $135; and the cost of connecting between house and road was $7. The last quarterly bill paid on May 12 was $6.29 net. The service charge amounted to $4.35. The consumption was only 88 kilowatt-hours. It is interesting to compare this bill with one paid on Nov. 22, 1924, which covered the three months ending October 31, 1924. The service charge then was $9.28, and the net bill was $12.35. At that time the rate for the first fourteen hours' use was 6 cents, and for the balance, 2 cents. Now the rate is 3 cents and 2 cents. In the meantime the number of consumers on the line has increased and a substantial refund has been made, since other consumers are helping to pay for the cost of the line and equipment.

As an example of the service used under Class 2B (50 acres or less in mixed farming districts) we might cite Arthur Dale, A. M. Scott and Robt. Brown. In the Dale home an electric range is in use, and power is used for lighting house and barn, operating an automatic compression water system, electric iron and toaster. The cost of wiring house and barn was approximately $200.

On the farm of A. M. Scott, Hydro has been used chiefly for lighting house and barn, with an occasional use of the electric iron and toaster. An electric range is now installed. The quarterly bill paid on May 5 was $7.21 net. The service charge was $6.75, and the consumption was only 42 kilowatt hours. This period was before the range was installed, and it will be observed that the power over and above the service charge cost only 46 cents.

In the home of Robt. Brown, Hydro is used for cooking, lighting, for the electric iron, toaster and for some auxiliary heating. The barns are lighted and a motor is used for pumping water. A light outside illuminates the entire yard.

Charles W. Parson comes in Class 3, which is a hundred acre service and up to a 3 horse-power motor. The installation in Mr. Parson's case cost approximately $250, but the dwelling and buildings are considerable distance from the road, which increases costs. There are 25 outlets in the dwelling and out-buildings. At present, Hydro is used for lighting, operating the washing machine and the electric iron. Wiring for a grate



A 3-h.p. motor in a barn, used to drive a milking machine, cream separator and chopper.

is now in, but the consumption for the grate is not yet reflected in the bills, which range around $10 net. The service charge is $8.85. In Mr. Parson's case, and generally throughout the neighbourhood, the rates in 1924 were 6 and 2, now they are 3 and 2. In the spring of 1927, Mr. Parson received a refund of $30.

Weldwood, "The Farmer's Advocate" farm, is classified as Class 3. Here Hydro is used for lighting throughout all the buildings, and in the house is used for cooking, washing, ironing, toaster and heater. In the out-buildings it is used for grinding, operating the cream separator and the fanning mill. The last quarterly bill paid on May 11 was $49.47 net, the service charge was $8.85. For the first two years the service charge was $16.50 quarterly. At the end of June, 1927, we received a rebate of $69.78.

This brief survey will give readers some idea of the cost of installation and the cost of service. These costs, however, very according to the number of users, the distance from the source of power and other relevant factors. The figures, however, are a reliable guide and an indication of how costs are apportioned.

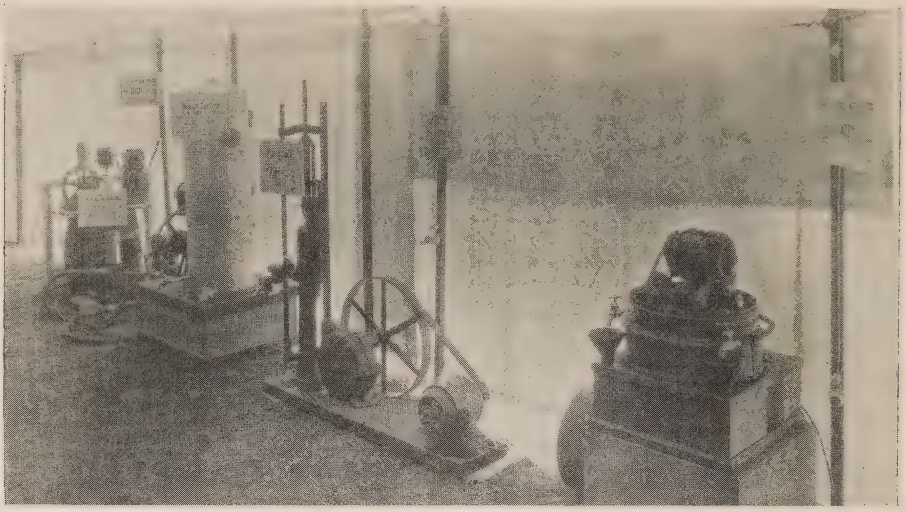
Demonstration at the Provincial Plowmen's Association Plowing Match at London

THE match this year was held in the London district on the farms of Carmichael Brothers approximately nine miles north of London on the 10th concession of London Township. The number of entries was probably the greatest in the history of the Plowmen's Association. The prizes donated were valuable and beautiful, and the number was the largest that the Plowmen have had at any place, being about 100 in all. The attendance was the greatest at any plowing match, ever held in the world. It is estimated that 91,000 people were in attendance in the four days of the match, the weather being exceedingly favorable with the exception, of course, of two very hot days. The areas on which the work was done were spread over about 400 acres, and a total of 117 acres were actually plowed.

The demonstrations included farm machinery, lighting plants and appliances, but did not include the heavier farm machinery except in the one case of a thresher driven by a tractor.

Our demonstrations consisted of the usual setup that has been made for several years, and which has been found quite satisfactory in the giving of information on the application of Hydro-electric power to farm work. Two tents were used, No. 1 to house the appliances for use in the home, and No. 2 to house some of the equipment which might be used in barns and dairies. In addition to the exhibits in the tents, arrangements were made by one of the motor manufacturers to carry on a chopping demonstration in co-operation with a chopper manufacturer. This part of the demonstration took place in the barn of the old homestead farm, and was much appreciated by all those

A part of the household appliance section. In this section was included a variety of ranges, washing machines, radios, table and laundry appliances. All kinds of equipment could not be shown, of course, and were not available for use.

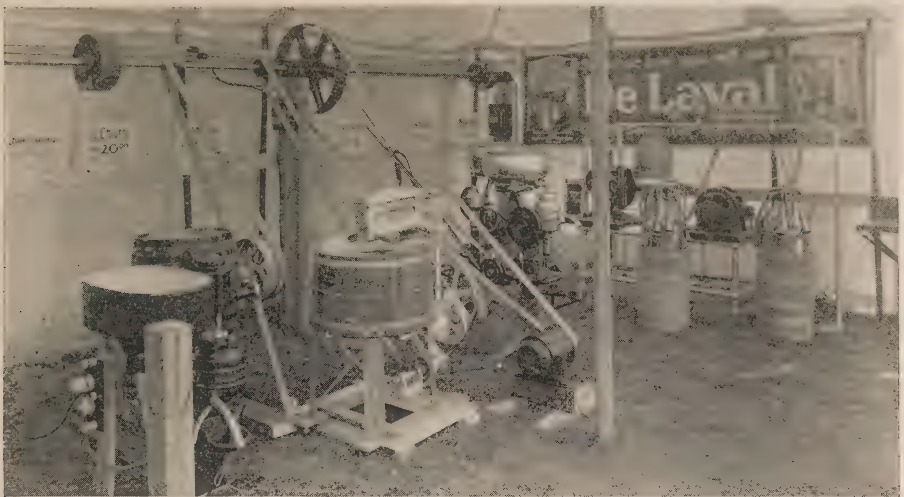


A number of water systems of different capacities and kinds were located along one side of the tent. These ranged in capacity from 200 gallons per hour to 600, and covered the plunger-type pumps, rotary pumps and the ordinary well force pump with gear jack drive belted to a half-horsepower motor. The pump supplying water service to the grounds is clearly indicated by the hose connections at the left of the picture, mounted on the ground. We believe that in twelve hours of operation each day we handled approximately 10,000 gallons of water for supplying water service, this being brought by suction from a spring located 800 feet north, the lift being approximately ten feet. The set-up was not ideal as far as the piping was concerned, as instead of making the entry to the spring outside the case and thence through the case, the piping was bent and pushed in from the top resulting in some lodgment of air in this bent section. After shutdowns, it took some time to displace the air thus lodged. The service however, was appreciated and was satisfactory. This pump operated continuously from 9 a.m. to 10 p.m..

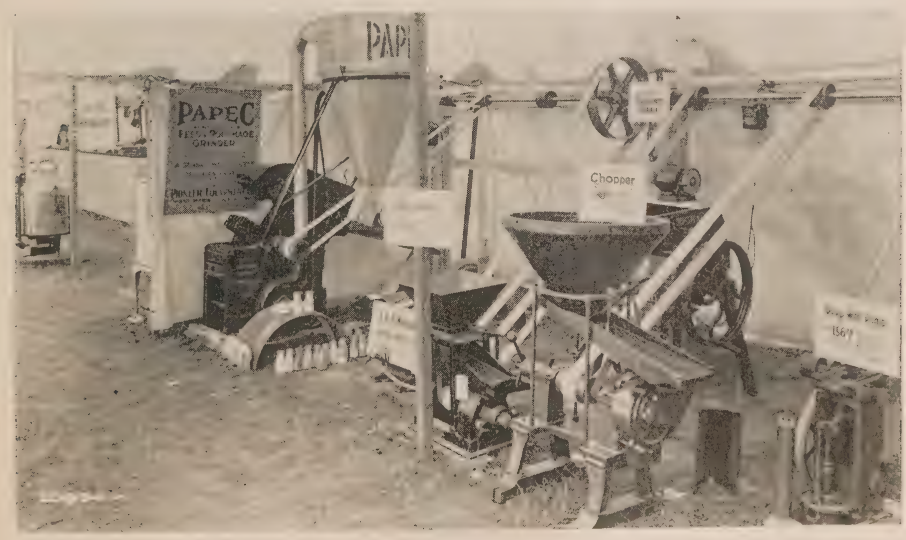
in attendance. The number attending the chopping exhibition was affected considerably by reason of the barn being some distance from our tents, and no cars being permitted to drive into this place on account of the parking regulations.

As an evidence of the distance that those interested travelled, it is worthy of note that approximately 5,000 cars were parked in the different parking areas and on the adjacent farms during the day of the great crush when the attendance was only a little less than 50,000 people. A bus service was maintained during the match between London and the grounds, and was so busy that at times there was a considerable delay in awaiting one's turn for transport by this method. It is estimated that at least one half the visitors at the match passed through the Hydro demonstration tents.

The Commission is indebted to the manufacturers who co-operated with them in making a success of this exhibit, particularly those who sent representatives to demonstrate their equipment, the R. A. Lister Company, Limited, Toronto, the De Laval



The dairy section which included two motor-driven cream separators made by different manufacturers, one belt-driven cream separator, a churn, a washing machine and a milking machine. The washing machine was introduced into this section as we find on many farms that the belted washing machine which was in use prior to having Hydro, is now used by belting to the line shafting in the dairy.



The barn section. A three-horsepower motor belted to a line shafting provided the drive for three different types of choppers, the object being to show the types as the three horsepower is not sufficient in two cases to supply the power for these choppers. A deep-well pump head and a root pulper were also included. A motor-driven grinder was mounted on the top of the root pulper for convenience.

The 5 h.p. motor shown was used to drive alternately the 9¾ in. chopper and a 13 in. blower box. The Hungarian hay on the floor at the right was cut and blown into the mow by the blower box. Oats and mixed grain were ground in a manner which the observers expressed as satisfactory.

Dairy Supply Company of Peterborough, the Pioneer Equipment Company of Guelph, the Wagner Motor Company, Toronto, the McClary Manufacturing Company of London, Beatty Brothers of London, Howe Brothers of London, and Kelvinator, Limited, of London, and the Public Utilities Commission of London.

The accompanying cuts show the extent of the demonstration. Much machinery and equipment, of course, could not be included in the limited area available in the tent space, but sufficient to illustrate the varieties and demonstrate the possibilities of the application of Hydro-electric power drive not only to the machinery which was actually on display, but other machinery which could be applied to the same form or similar forms of drive.

Canadian Electrical Code

A GOOD deal has been published in the technical and daily press within the last year regarding the Canadian Electrical Code, and the readers of THE BULLETIN may be interested in learning something about this publication.

The Code, as its name implies, is a set of Rules governing inside electrical installations. Its preparation was undertaken by the Canadian Engineering Standards Association several years ago following requests from various electrical interests throughout the country, and in answer to a practically universal demand from many sources for rules which would be uniform throughout Canada.

The matter of legislating regarding electrical inspection is within the jurisdiction of the Provinces and municipalities, and the situation when the Code work was undertaken was that many different sets of rules were in operation in the various Provinces, and in many cases in different cities within the same Province. This condition imposed hardship and inconvenience upon manufacturers of electrical equipment and upon inspectors and contractors, and was therefore highly undesirable. The Canadian Engineering Standards Association undertook the work of preparing a Code, and after several years of effort the first draft of the Canadian Electrical Code was adopted at a meeting in Winnipeg in June, 1927.

The actual work of preparing the Code was entrusted to two compilers who combined the desirable features of existing Canadian rules and embodied in the draft the suggestions received from all parts of the country. The first draft was prepared by Professor McKnight and Mr. H. F. Strickland, and a further draft for the Winnipeg meeting by Messrs. Barnes and Strickland.

After the adoption of the Code at the Winnipeg meeting, it was published and distributed to all parts of the country. It was within a year adopted by the Provinces of British Columbia, Saskatchewan, Ontario, Quebec and Nova Scotia. In Ontario the Hydro-Electric Power Commission was empowered by legislation to administer the rules, and had been administering such rules for many years. In British Columbia and Nova Scotia the conditions were somewhat similar, but in the other Provinces it was necessary to enact legislation before the Code could be adopted. As it has just been stated, legislation was enacted in Quebec and Saskatchewan in 1928, and it is expected that several other Provinces will follow suit in 1929. The progress of the Canadian Electrical Code has thus been very satisfactory, and it may be stated that the work has been very successful since the most populous Provinces of the Dominion have adopted the Code.

In order to understand the magnitude of the task involved and the manner in which it was carried out, a word regarding the organization of the work is necessary. A committee was appointed by the Canadian Engineering Standards Association and was instructed to prepare

the Canadian Electrical Code. This committee included representatives from all electrical interests in Canada and was composed of about thirty men. Supplementing this committee there were formed committees in each of the Provinces interested, and these committees reported to the main committee their suggestions for rules to be incorporated. The various drafts of the Code were circulated first to the Provincial Committees for criticism and comments, and when these had been thoroughly discussed, the draft was presented to the main committee for further discussion and adoption.

During the year following the Winnipeg meeting of 1927 many suggestions regarding additional rules were received from various sources, and it became evident that a meeting would be necessary in 1928. In order to prepare for this meeting and to inform the various Provincial Committees of the work being carried on in other Provinces, Mr. B. Stuart McKenzie, Secretary of the Canadian Engineering Standards Association and Mr. W. P. Dobson of the Commission's staff, Chairman of the Main Code Committee, visited eight of the Provinces during the past summer, and upon their return a meeting was arranged in Montreal for September 26 to 28 incl. At this meeting there were present about 40 delegates, including representatives from eight Provinces. A very thorough discussion of the Code and the suggested revisions resulted in the adoption of many of these revisions. The second edition of the Code will be published in a few months, and it is expected that it will be adopted throughout the entire country in the near future. It is believed that this Code is in advance of most existing Codes on the North American continent, and that it reflects the latest practice in electrical installation work. It deals very fully with methods of wiring for all types of installations, with the subjects of grounding, protection of circuits and apparatus, and embodies some valuable material on demand factors which will assist inspectors and contractors to a considerable extent in the work of designing and inspecting installations.

It is expected that no major revisions will be required for at least two years, and the next meeting of the Main Code Committee is tentatively arranged for 1930. In the meantime the Provincial Committees will meet regularly and will exchange views on the suitability of the rules and on suggestions for revision.

The Commission has taken an active part in this cooperative work, and several members of the staff serve on the Main Committee and on the Ontario Provincial Committee. The compilers of the present edition, Messrs. A. S. L. Barnes and H. F. Strickland, have done valuable work which received expressions of appreciation from the meeting in Montreal.

The Commission has also rendered service through its Approvals Laboratory, the findings of which have been accepted for several years in many parts of the country. The findings of the laboratory are recognized by the Canadian Electrical Code.

Survey of Neon Signs

By H. A. Cook, The Detroit Edison Company, Detroit, Mich.

(A paper read before the 22nd Annual Convention of The Illuminating Engineering Society, Toronto, Sept. 17-20, 1928.)

APPROXIMATELY two years ago, activity in the manufacture and sales of Neon Signs in the territory served by the Detroit Edison Company was started. The acceptance of the form of advertising by merchants and industrial executives was so rapid and of such importance that it became necessary for this company to obtain information for its use in order to be in a position to determine costs of operation, etc.

An indication of the success of the effort put forth in the introduction of this advertising medium can be appreciated when it is estimated that there are at the present time approximately 15,000 exposed and enclosed lamp signs in use and 600 Neon signs installed and serviced.

If the fact that over 65 per cent. of these Neon signs have been installed within the past year is considered, the importance and growth of this advertising medium can better be appreciated.

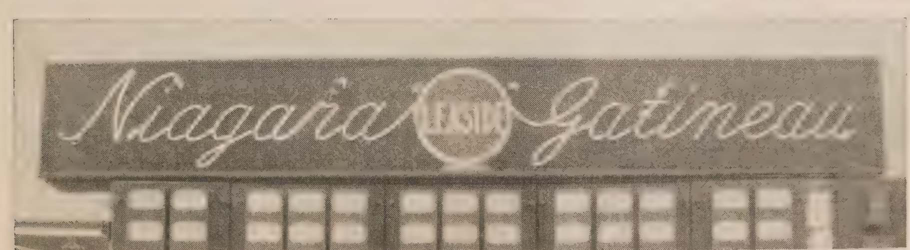
Scope of Investigation

Perhaps some of the questions lighting men are confronted with would be of value in outlining the reasons for this investigation. Comparatively representative questions follow:

1. What do you know about these new Neon signs?
2. How much will it cost me to operate a Neon sign?
3. Will it make a change necessary in my lighting contract?

It is obvious to all that inasmuch as the answer to the first question, *i.e.*, "What do you know about Neon Signs?" was, before these tests were conducted, "Nothing," the two following are unknown. Hence the necessity for this information and the resultant tests.

The tests, then, should include, information that deals directly with the relationship between the customer and the Public Service Company. This relationship centers



Single tube sign used at opening of Leaside Station.

itself, in a purely practical way, around the cost of operation. The service and good will features are ever present, but in the final analysis, any additional use of electrical energy always depends upon the justification of the increased cost of that service. The theory of the luminous tube operation, problems in manufacture and marketing the product are not in any manner, shape or form involved in this paper.

Factors to be Determined

Inasmuch as Neon or luminous tube signs are of various sizes, shapes and designs, any means of estimating the cost of operation upon factors other than a unit length of tube would be useless because no definite standard or means of measurement could be set up. If, however, it is agreed that some definite sign or luminous tube installation is contemplated, certain information regarding this installation will be available. This information would in the main consist of the diameter of the tubes used, the number of feet of tubing to be installed and whether or not the sign was to be used with a.c. or d.c. energy supply.

Based upon these facts the logical means of comparison would be to determine the wattage per foot of tube of a certain diameter used on a.c. and d.c. circuits. If this has been determined, the necessary information can readily be supplied for any installation in use or for any one proposed.

Method of Taking Tests

Tests were made in both a.c. and d.c. districts. The respective methods of test are as follows:

(a) *Direct Current District.*

On the input side, *i.e.*, the d.c. service side, the watts consumed were noted in order to compute the total watts consumed per foot of sign. This represented the actual revenue producing load.

On the output side, *i.e.*, a.c. side of the converter, the amperes, watts and volts were taken. From these observations the power factor and a.c. watts per running foot of sign were computed.

The power factor was obtained by dividing the output in sign watts by the product of the output volts and amperes. Meter connections were made at the rotary converter on the d.c. and a.c. sides.

(b) *Alternating Current District.*

In this district readings were taken for watts, volts and amperes. From these observations the power factor and watts per running foot were obtained. Power factor was computed in the manner outlined under Direct Current District.

Readings in this district were taken either at the main fuse box or at the smaller fuse box on the time clock. In all cases the readings were instantaneous.

Results of Tests

The following tables give in detail the results obtained by the methods described under Methods of Test. In order to simplify the presentation and at the same time call attention to the differences in the signs tested, two general classifications have been made, these classifications being dependent upon the diameters of the tubes used. This method of classification was taken because it seemed

TABLE No. 1.

DIAMETER OF TUBING 12mm. ENERGY SUPPLY-AC			
LENGTH	POWER FACTOR	WATTS PER FOOT	BURNING HOURS
65'-0"	.34	7.46	6
112'-0"	.56	8.03	24
122'-0"	.352	6.40	8
208'-0"	.380	8.65	6
416'-0"	.420	11.33	6
AVER. 184'-7"	.410	8.37	10

TABLE No. 2

DIAMETER OF TUBING-12mm.-ENERGY SUPPLY-DC.				
LENGTH	POWER FACTOR	AC WATTS PER FOOT	DC WATTS PER FOOT	BURNING HOURS
61'-8"	.370	8.15	20.21	16
88'-10"	.530	5.47	18.14	6
210-0"	.285	4.95	28.57	15
258'-6"	.380	11.61	24.2	6
262'-0"	.400	7.48	14.88	24
AVER-175'-10"	.393	7.53	21.20	13.4

TABLE No. 3

DIAMETER OF TUBING-15mm.- ENERGY SUPPLY-AC.			
LENGTH	POWER FACTOR	WATTS PER FOOT	BURNING HOURS.
25'-6"	.426	6.19	24
40'-0"	.365	6.5	6
73'-4"	.432	7.30	24
73'-4"	.514	7.90	24
87'-0"	.538	5.4	24
87'-10"	.445	7.7	10
88'-0"	.512	6.44	24
100'-9"	.51	7.34	16
111'-6"	.547	6.18	6
119'-1"	.472	6.47	7½
123'-4"	.435	6.45	18
171'-2"	.414	5.62	10
177'-0"	.395	6.44	24
177'-1"	.593	6.44	18
179'-7"	.559	5.82	10
248'-0"	.480	5.4	7
267'-0"	.468	5.76	24
296'-6"	.518	4.45	13
296'-11"	.557	4.37	24
311'-4"	.429	4.43	6
416'-0"	.440	4.61	8
AVER. 165'-3"	.476	6.06	15.6

TABLE No. 4

DIAMETER OF TUBING-15mm. ENERGY SUPPLY DC.				
LENGTH	POWER FACTOR	AC WATTS PER FOOT	DC WATTS PER FOOT	BURNING HOURS
52'-2"	.730	8.63	18.42	13
66'-6"	.550	5.61	14.54	11½
73'-8"	.509	6.10	15.07	12
77'-6"	.440	6.06	12.90	
107'-1"	.413	8.5	13.44	15
132'-2"	.680	7.27	9.54	16½
132'-2"	.585	7.46	13.43	13
163'-0"	.515	3.86	7.85	13
192'-0"	.520	5.41	9.37	9
240'-0"	.421	4.33	5.66	12
269'-3"	.505	4.90	7.68	10
AVER-136'-10"	.533	6.19	11.63	12.5

TABLE No. 5.

GENERAL SUMMARY OF TABLES Nos. 1, 2, 3 & 4.			
TUBING DIAMETER	AVER. POWER FACTOR	AVER. AC WATTS PER FT.	AVER. DC WATTS PER FT.
12 mm.	.410	8.37	21.20
15 mm.	.476	6.06	11.63

the most logical, inasmuch as no other considerations, such as the size of sign, etc., seemed to provide a basis for comparison. A subdivision of each classification has been made, this being based upon the character of the energy supply, whether it be alternating current or direct current.

Conclusion

From the observations made during these tests several facts seem of importance to Public Service Companies.

These are:

(*a*) Neon signs are good revenue producers. The long burning hours make this a very desirable load.

(*b*) Their power factor is not of the highest order, but inasmuch as the signs are normally used in connection

with a large incandescent lamp load, the power factor of the entire installation is so high that consideration of the power factor of the sign itself is comparatively unimportant.

(*c*) Where maintenance contracts are included in the purchase of signs, no trouble should be experienced due to outages, etc., these being taken care of by the sign company and not the consumer.

(*d*) A general stimulation of the sign business has resulted since the introduction of this new advertising medium. Incandescent lamp signs are being used for longer hours and merchants are becoming more conscious of the value of electrical advertising.

He Laughed

He laughed when they told him the ladder was weak,
And remarked it would hold half a ton.
It cost him a hundred to settle the bill
When the doctor and nurses were done.

He laughed when his foreman urged greater care
As he carelessly cleaned the machine.
The doctor remarked, as he bound up the wound,
"It's the very worst mangling I've seen."

He laughed when the doctor ordered him home,
For a couple of days with a cold.
In a ward for consumptives he thinks of the past,
It's too late now to help him, he's told.

He laughed when told that infection might come
From leaving a cut undressed.
'Tis said he looked natural as if asleep,
His headstone says he's "At Rest."

He laughed when told to go light on food,
He said he would eat what he chose.
The funeral was large, the music was fine,
On his grave was planted a rose.

He laughed when they warned him to drive with due care,
And he struck a sixty mile clip.
The judge fined him fifty, and gave him three months,
He had broken only one hip.

He laughed when advised to insure his life,
And said he would live forty years.
His widow does washing to earn her support
And he might have saved her the tears.

—*The Tattler.*

Prone Pressure Resuscitation

By Wills Maclachlan, Employees Relations Dept. H.E.P.C. of Ont.

PRACTICALLY everybody connected with an electrical public utility has received instructions in the Prone Pressure Method of Resuscitation which, although very simple, has been extremely effective in saving lives that but for its action very likely would not have been saved. Few, however, know very much about the eminent physiologist who was the originator of the method. At the time that the method was put forward, Sir Edward S. Schafer wished the method to be called the Prone Pressure Method, explaining that the person was placed in a prone position and pressure was used, hence his name has not been so intimately connected with the name of his method as the names of others who have developed some of the earlier methods.

Sir Edward Sharpey Schafer, F.R.S. was born in London, England, in 1850. He was Assistant Professor of Physiology from 1874 to 1883, University College and Jodrell Professor from 1883 to 1899. He was appointed Professor of Physiology of the University of Edinburgh in 1899, which chair he still occupies.

During his life many honours have been paid to him, among which are the following :

Honorary LL.D., Aberdeen, 1897, McGill, 1908, St. Andrews, 1911.

Honorary D.Sc., Trinity College, Dublin, 1905, Cambridge, 1914, Melbourne, 1914, Oxford, 1926.

Honorary M.D. Berne, 1910, Gromingen, 1914.

Baly Medal, College of Physicians, 1897.

Royal Medal, Royal Society, 1902.

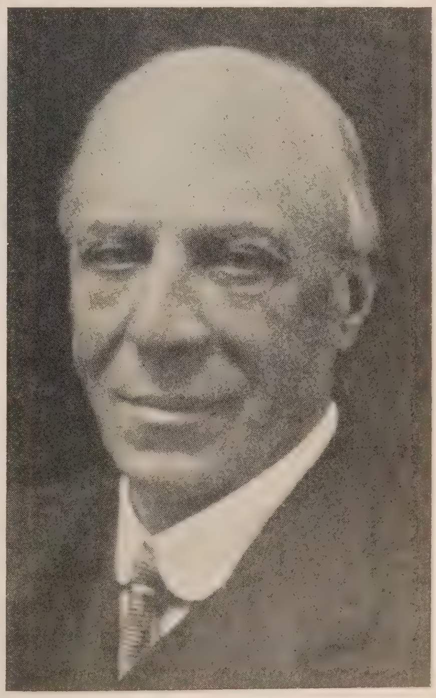
Distinguished Service Medal, Royal Life Saving Society, 1909.

General Secretary, 1895-1910.

President, 1912—British Association for Advancement of Science.

Original Member Physiological Society, 1876.

Honorary Fellow : Royal Medical Society, Edinburgh; Philosophical



Sir Edward Sharpey Schafer

Society, Glasgow; Royal Medical Society, London.

Honorary Member: American Medical Association; Societie Biologique, Paris; Societie Biologique, Argentine, Buenos Aires.

In the latter part of the last century there were a number of different methods of resuscitation receiving attention and being used in accident cases. The Royal Medical and Chirurgical Society of London appointed a Committee of which Sir Edward S. Schafer was Chairman. This Committee reported in 1903, and incorporated in its report the now celebrated Prone Pressure Method. This method was not known to any great extent on this side of the Atlantic until Sir Edward Schafer gave his Hunterian Lecture in 1909. Since that time, various Commissions composed of members of the Medical and Engineering professions have, after investigation, endorsed this method and quite recently a complete survey of the situation was carried out with the result that a standard technique of Prone Pressure Resuscitation has been developed.

The public utility industry, as well as the public generally, owe a sincere debt of gratitude to Sir Edward S. Schafer for the simple, efficient method that was put forward by him and which after twenty five years has been only very slightly modified in the light of field experience.

An example of good housekeeping. This is a picture of the garden at the rear of Simcoe Rural Power District office. Two years ago there was a chicken coop in the left hand corner, and the centre and right hand side were filled by a junk pile, showing evidences of a very ancient civilization. The spot has been cleaned up, and the garden developed by the rural staff. One interesting relic unearthed during the gardening process was a very ancient type of bayonet, which is an evidence of the spot having been the scene of a battle. The lawn is the only bit of reinforced grass in the country, the soil being thoroughly impregnated with chicken wire.

Housekeeping for Power Houses, Substations, Storehouses and Other Public Utility Properties

(Extract from N.E.L.A. Publication No. 278-67)

HOUSEKEEPING for power houses, substations, storehouses and utility properties in general, embraces many and varied elements that cover a surprisingly large field of activities. The importance of this subject cannot be too strongly emphasized. Good housekeeping is fundamental to maintaining continuity of service and is essential to successful and economic operation of utility properties.

There are two outstanding features of good housekeeping — orderliness and cleanliness. These are never accidental but are the results of planning, system and supervision. Then comes the most important element—inspection. Intelligent, earnest study of inspection methods plus hard conscientious work by every person in the organization is necessary to secure the best results. A system of inspections should be started and maintained.

Written plant inspection reports covering buildings, equipment and contents should be carefully made, kept and checked until any hazardous conditions have been corrected. These reports should cover fire hazards, maintenance of fire fighting equipment, installation of equipment and apparatus, storage conditions, cleanliness of buildings, cleanliness and upkeep of yards and adjoining properties. This routine should have a tendency to develop a sense of good housekeeping among the employees and should result in better cooperation of the working force.

Maintenance and Upkeep

Buildings, grounds and outdoor structures require constant supervision to maintain them in a proper state of repair and in satisfactory condition. Without this constant supervision unhealthy conditions of the physical properties will arise. Prolonged neglect will surely result in such dilapidation as to require replacements in many cases when comparatively simple and inexpensive repairs made at the proper time might have prevented deterioration. Both the inside and outside of building structures should be rigidly inspected and any defect, no matter how small, should be given immediate attention. This attention to detail insures that the structure is thus maintained in a creditable condition, and produces a favorable reaction in the mind of the operating force and tends to a better spirit of cooperation among the entire personnel of the organization which is particularly desirable.

All outside structures, in general, should be painted alike, but even this rule need not stand in the way of making some particular structure conform in appearance to its surroundings, if, for some reason this course seems desirable. Modern generating plants, substations and relative buildings, however, are as a rule

fire resistive, but many other buildings are not. Therefore, the question of painting enters very little into the exterior appearance of modern structures.

The interiors, and this applies to structures and apparatus, should be kept well painted, and floors and walls should be looked after in this respect. The color scheme should be agreeable, cheerful, and well blended in order to contribute its share toward a proper frame of mind, and of such tint and consistency as will produce the largest quantity of reflected light possible from such surfaces. Inside structures and apparatus should be painted chiefly because of utilitarian reasons, but even these should be so colored that they will blend nicely with the building colors and not produce sharp contrasts.

The grounds surrounding the buildings, both operative and inoperative, should be kept clean and neat and, if possible, should be cultivated so as to present a pleasing aspect. Well-kept lawns, a generous supply of shrubs and, where practicable, a few trees, selected and placed with care, will add materially to the general appearance. Where personal supervision can be given by the operating force, flower beds with well-chosen combinations can well be made a part of the landscape gardening. The grounds of outdoor stations generally are covered with crushed rock and do not lend themselves to decorative effect, but even these structures can be so maintained as to blend well with the surroundings.

Storing of Materials

The careless and untidy storing of materials in storerooms and plants may occasion both fire and accident hazards. Often when a shipment of material arrives the cases are opened and allowed to remain unpacked for several days, and the excelsior, sawdust or paper packing constitutes a very serious fire hazard. Special care should be exercised that material piled near aisles and passageways is not likely to fall, or to be knocked over; the piles should not be too high; neither should parts extend into the passage or roadway where passing men or trucks may strike against them.

Proper provisions should be made for the storing and handling of miscellaneous oils, paints, etc., and when small quantities are withdrawn for use, any portion left over from the day's supply should be returned to storage. The practice of storing materials in operating rooms of power houses, substations, etc., constitutes a serious fire hazard and should not be permitted.

Lighting and Ventilation

The lighting and ventilation systems should be maintained in good operating condition. A well designed artificial lighting layout is an essential upon which too much stress cannot be laid and this applies equally as well to ventilating by natural or artificial means. Poor ventilation and bad lighting result in physical and mental reactions which are detrimental to service and cause diminution of alertness.

Fire Prevention

Although the modern building housing electrical apparatus and

equipment is constructed in conformity with the best engineering standards for fire resistive qualities, nevertheless some electrical apparatus and equipment necessarily contain materials of a combustible nature. A fire hazard therefore exists but such fires are easily kept under control. In order to place the combating of such fires on an efficient basis, each building should be equipped with a full complement of fire extinguishing devices carefully selected for the building in question and located in conspicuous and accessible places. The proper selection of extinguishing devices for each particular building necessitates a thorough knowledge of each and all items in the building, electrical and otherwise, from the standpoint of possible fire hazard, and the selection should be made on the basis of efficiency of each extinguishing device in combating each class of fire.

Extinguishing devices have certain rather definite characteristics and applications. Because of such differences, certain devices have come to be recognized as particularly adaptable for certain classes of fire and this tends to simplify the investigators' task in selecting the proper extinguishing equipment. It is advisable to submit proposed installations to a check by the engineers of the insurance rating bureaus. This will also facilitate securing proper credit in the insurance premium.

Closely associated with the fighting of fires is the danger from fumes of some extinguishing agents and from suffocation due to smoke. To protect the employees against these hazards, gas masks of an approved type should be supplied in confined areas where the ventilation is insufficient to remove the fumes or gas. Those masks should be conveniently located so as to be instantly available. Definite instructions and frequent practice in the use of these masks should be given to those concerned.

Great stress should be placed on the absolute necessity for frequent and periodic inspection, care and maintenance and instructions in use of all fire extinguishing apparatus and gas masks to insure 100 per cent. utility. It is desirable to locate extinguishers on a specifically marked background. Through constant association employees become familiar with the different locations of fire fighting devices and it becomes second nature for them to make the proper selection.

Cleanliness

The desirability of cleanliness in and about stations and buildings is so unquestionable that no particular argument need be advanced in support of it, but even so it frequently happens that too little attention is given to attain this end.

The necessary cleaning supplies such as tools, brooms, dust pans, mops, mop pails, sponges, etc., should be furnished unstintingly. In the larger stations it has become recognized as economy to install modern labor saving appliances for the use of the clean-up crew. Having provided the necessary equipment and clearly defined the standards of cleanliness in and about the buildings, steps should be taken to see that the established standards are maintained.

It is sometimes difficult to prevent accumulations of litter and dirt,

particularly in basements, at the bottom of elevator shafts, under piles of materials, and other out-of-the-way places. Such conditions, however, can be prevented if proper measures are taken. Extreme care should be given the storage of rubbish and useless material, and prompt removal from premises should be the rule. Wooden boxes should never be used for temporary disposition of these materials.

Greasy and oily waste is subject to spontaneous ignition and the greatest care should be taken in its disposition. Unless it is immediately burned after use, waste should be deposited in standard metal waste cans. The construction of the waste can is of vital importance, and non-standard cans are of but little value. The old-style wooden closets, lockers and enclosures are sometimes used as a catch-all for discarded and greasy garments all of which increases the fire hazard. Substantially constructed and properly ventilated metal lockers for employees' clothes should be installed.

Cleanliness of machines and other equipment, such as transformers and oil switches is another house-keeping requirement that is particularly important. Machines covered with grease and oil are dangerous for operators and repairmen to work around. Where oil and grease are allowed to collect on a machine, the floor usually becomes soaked, thus increasing both fire and accident hazards.

Education

The education of the operating force along these lines and the gradual attainment of these standards is no light task and requires both energy and tact in no small degree, but once this mental attitude of good housekeeping is developed it is a comparatively simple matter to maintain it. Constant and rigid supervision, however, is necessary. One of the best means to accomplish this is to provide well defined and explicit inspection forms and an established practice of reporting and supervising.

Cooperation

The foregoing statements as to what should be done to maintain desirable housekeeping conditions very naturally gives rise to the question, how can all this be accomplished? There are many ways in which this can be done, but the best results may be obtained with the smallest expenditure of time by close cooperation between those charged with the supervision of such matters and the operating force.

Hydro News Items

Central Ontario System

The 1,500 kv-a., 2400–4200 volt, 60 cycle, synchronous motor which for a number of years operated the d.c. generator for the Peterboro Street Railway and also corrected the power factor of the municipal load was jointly owned by the Commission and the Peterboro Public Utilities Commission. The Commission has purchased the Public Utilities' share in the machine and the entire motor generator set is now for sale.

* * * *

The Strathcona Paper Company is abandoning its present steam equipment and will take its entire load of over 400 h.p. from our lines.

* * * *

The Printers Guild has erected a new factory about three-quarters of a mile west of the village of Pickering. They have signed a contract for 30 h.p., and our lines will be extended to give the service.

* * * *

The Oshawa City Council on October 15th passed a by-law authorizing the purchase of the gas plant and electric distribution system now owned by the Commission. This action of the Council was taken on the recommendation made by the Central Ontario Power Association, *viz.*, that all the municipalities own and operate their electric utilities.

It is said that the Hydro Manager at Cobourg can Skid more poles than any of the others and that is why the pole yard is at Cobourg. Of course it is quite a Chace from some parts of the system to Bowmanville and the Barnes at Oshawa are equally unhandy. The Cole man at Port Hope was considered as also Peterborough where Ol' Dobbin does that kind of work. Belleville was left Scott free.

* * * *

Niagara System

Power for construction work on the new Windsor-Detroit vehicular tunnel is being supplied by the Sandwich Rural Power District. The work is being carried on on the property of the Canadian Steel Corporation in Ojibway. The steel tubes are to be constructed largely by electric welding and will be floated in sections upstream a distance of approximately five miles to the location of the tunnel.

* * * *

Application has been received by the Sandwich Hydro-Electric System for a supply of power for lighting one side of the new Windsor-Detroit suspension bridge, which, it is reported, will be opened to traffic about July 4, 1929. Power for lighting the other side of the bridge will be obtained from The Detroit Edison Company.

The Ingersoll Rural Power District has increased to such an extent as to warrant the opening of a field office. This rural Power District has been taken care of in the field for the Commission by the Tillsonburg Rural Power District staff during the early development.

* * * *

Arrangements are being made to add an additional 3,000 kv-a., three-phase transformer at the Commission's New Toronto substation and it is considered advisable to change the voltage in New Toronto in the near future from 2,200 to 4,000 volts.

* * * *

The Palmerston Public Utilities Commission will very shortly complete the installation of new domestic and fire pumping equipment. Two new 12 in. wells have been drilled to a depth of about 110 feet. Deep well type centrifugal pumps each having a capacity of 350 gallons per minute pump directly into the mains for the storage reservoir. The pumps are driven by vertical type motors of 35 h.p. capacity and an auxiliary gasoline engine will be mounted between the two wells to enable either pump to be operated in case of failure of the electrical equipment. The steam pumping equipment has been discarded and fire protection is now taken care of by two centrifugal pumps, one driven by a 100 h.p. electric motor and the other by a 150 h.p. Sterling gasoline engine. The municipality is also constructing a sewage disposal plant which will require approximately 3 horse-power to operate. The municipality is to be congratulated on the completeness of the equipment installed.

The Commission is proceeding with the construction of a heavy capacity, double circuit, steel tower, 110 kv. line from Pelham (near the Welland Canal) direct to St. Thomas. This line will be connected at Pelham with two circuits recently constructed from Queenston. It is expected that this line will be in operation next summer, the result of which should mean improved voltage and general service conditions to all municipalities in western Ontario.

* * * *

On October 1st, the date upon which the Commission was obligated to take power from the Gatineau Power Company, the new 220,000 volt line from Ottawa River to Leaside and one bank of transformers at the Leaside Station went into operation. The second and only remaining bank of the initial installation went into operation on October 14th. The Commission is now taking all the power to which it is entitled under the contract for the coming year. In order to utilize this power on the Niagara System, the new 110,000 volt line from Leaside to Bridgman Station, across the centre of the City of Toronto, also went into operation on October 1st.

* * * *

St. Lawrence System

A rural line is under construction from Morewood to Crysler, to supply rural and residents of Cannamore and Crysler, in the Chesterville Rural Power District.

* * * *

Construction is approved of a rural line from Finch to Newington in the Chesterville Rural Power District.

A rural line on the Provincial Highway east of Morrisburg, is under construction to supply consumers in the Williamsburg Rural Power District.

Construction is completed of a rural line on the Provincial Highway west of South Lancaster, in the Martintown Rural Power District.

A modern application of an ancient principle. This plant is to be found in Franconia Notch in the White Mountains in the State of New Hampshire. Water is lead over a wooden flume for approximately 600 feet and drives the overshot water wheel, which is approximately 16 ft. in diameter. The building houses a small d.c. generator to serve a roadhouse nearby. Though the plant was built about two years ago, it would appear that efficiency was a minor factor in its design.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

New 15,000 kv-a. Transformer Station Near Smiths Falls

THE erection of a 15,000 kv-a. transformer station in the vicinity of Smiths Falls has recently been completed. This station is located on a four-acre site adjoining the Smiths Falls-Brockville branch of the C.P.R. at a point two miles south of the C.P.R. station in Smiths Falls.

The 60-cycle power under contract from the Gatineau Power Company, is transmitted to this station at 110,000 volts from the Ottawa River at Ottawa. It is here transformed to 44,000 volts and initially will be transmitted to the St. Lawrence and Central Ontario Systems at the latter voltage.

All of the equipment comprising this station is installed outdoors. The bus structure is constructed of wood poles and timbers. Equipment foundations are of concrete. The control equipment and battery are housed in a small building 20 feet square constructed of wood, lined with "Gyproc" and having a concrete floor.

110,000 Volt Equipment

The 110,000 volt incoming line is controlled by a Type "G-22A" oil circuit breaker manufactured by the Canadian Westinghouse Company. Lightning protection is afforded by a 121,000 volt Type "OF" Oxide Film lightning arrester manufactured by the Canadian General Electric Company.

Transformers

The 15,000 kv-a. transformer bank was manufactured by the Canadian General Electric Company. It is composed of three 5,000 kv-a. units (with a spare unit) and a "Regulating" transformer which provides facilities for changing taps under load. The main units are of the three-winding type rated at 5,000 kv-a., 63,500/25,400–4,160 volts. The high

CONTENTS

Vol. XV **No. 11**

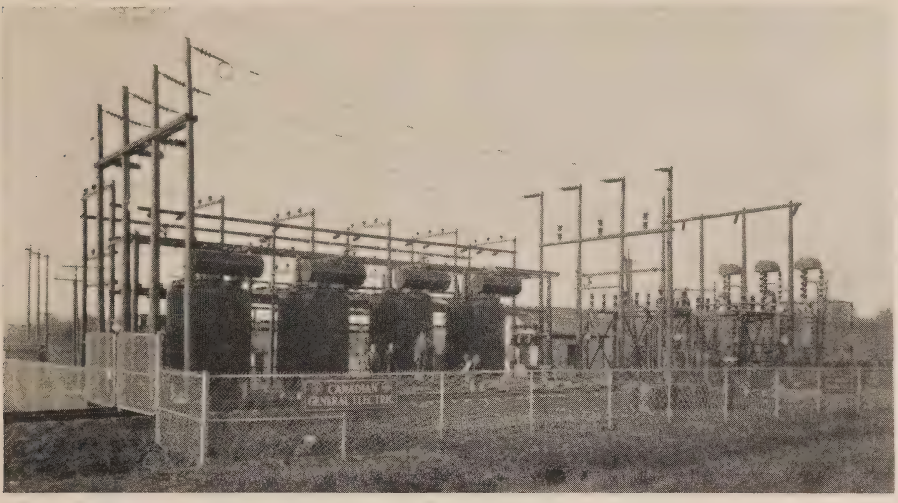
November, 1928

	Page
New 15,000 kv-a. Transformer Station near Smiths Falls - - -	365
New 44,000 Volt Switching Station at Kingston - - - - -	369
Electrolysis and its Mitigation	370
A.M.E.U. Note - - - - - - -	376
Application of Hydro-Electric Power to Farm Work - - -	377
Why not an Electro-Chemical Industry - - - - - - -	382
Setting Poles with Dynamite - -	390
Television - - - - - - - -	392
Hydro News Items - - - - -	395

voltage winding is provided with three 2½ per cent. taps, one above and two below its rating. These taps may be changed, when the bank is de-energized, by means of an external mechanism mounted on the side of each tank. The neutral ends of the 25,400 volt windings are connected to the series windings of the "Regulating" transformer. The 4,160 volt windings are connected to a delta bus.

The "Regulating" transformer which forms part of this bank, is the unit which accomplishes the changing of taps under load in four 2½ per cent. steps above and below normal. It is a three phase unit composed of two separate transformers, one above the other in one tank. The upper one is an auto-transformer which has nine taps per phase. Its full winding is connected to the 4,160 volt delta bus. The lower transformer has two windings known as the "Series Winding" and "Excited Winding." The taps of the auto-transformer provide the variable source of voltage for the "Excited Winding," the value and polarity of which determines the amount of "buck" or "boost" voltage that the "Series Winding" will apply to the potential of the main transformers. The middle point of the auto-transformer is connected to the middle point of the "Excited Winding" and oil circuit breakers control each half. To change a tap one breaker opens de-energizing one-half of this winding in each phase. The

Smiths Falls Transformer Station. View looking east, showing 110 kv. line entering on the left and control room in the foreground.

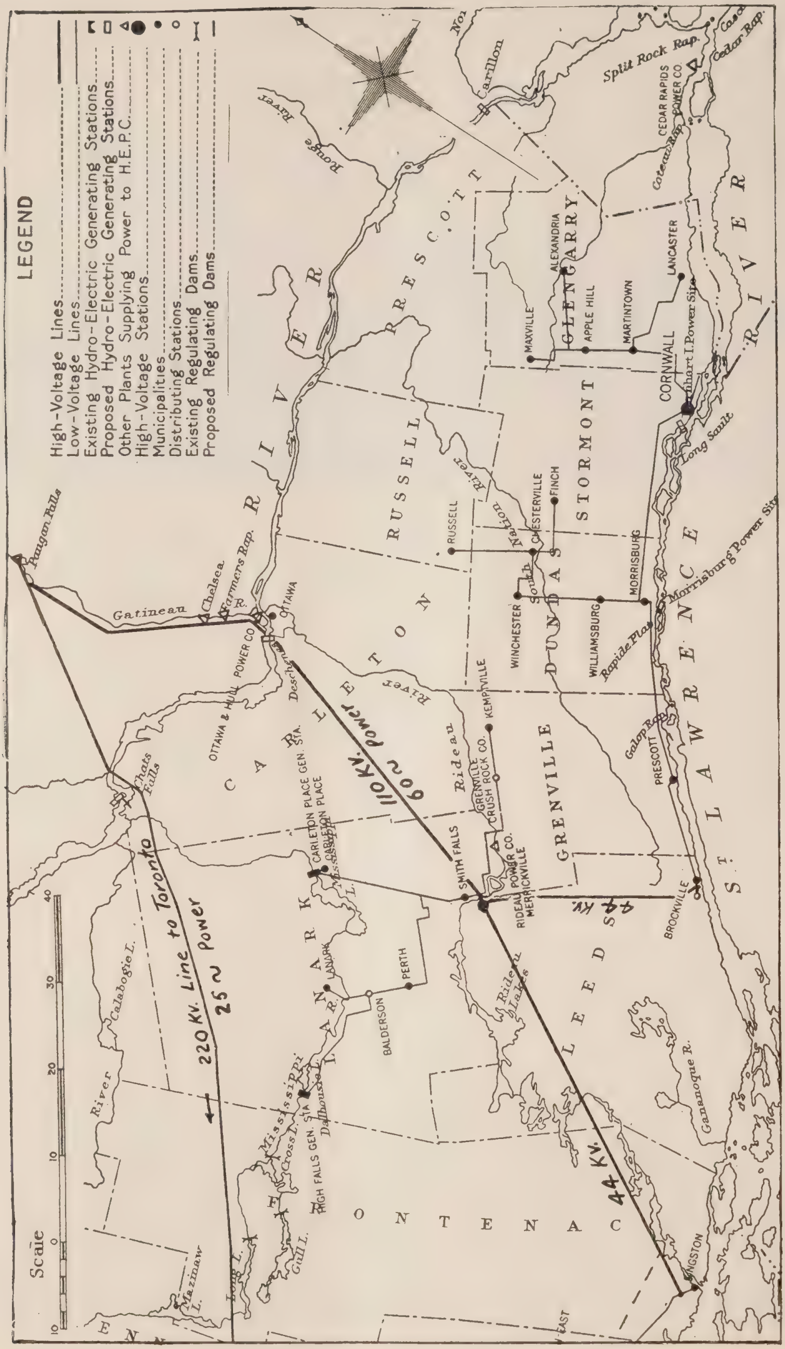


Smiths Falls Transformer Station, view looking west, showing 5,000 kv-a. transformers and 110 kv. bus. The spare transformer is on the left and the "Regulating" transformer will be on the right, but was not installed when the photo was taken.

ratio-adjuster then moves from one tap to the next and the breaker recloses, thus completing half the sequence. This operation is repeated for the other half, thus completing the cycle for one tap change. The time consumed for each cycle is approximately thirteen seconds. Tap changes may be made by electrical control from a push-pull control switch mounted on the switchboard or manually by a crank at the transformer. The tap position is indicated by a dial at the transformer and also by a remote indicator mounted on the switchboard.

Each of the transformers comprising this bank are of the self-cooled

Smiths Falls Transformer Station, view looking north, showing the two 44 kv. lines in foreground.



Map showing the location of the 110 kv. line from the Ottawa River near Ottawa to Smiths Falls and 44 kv. lines from Smiths Falls to Kingston and to Brockville.

type. External tubes around the tanks provide the radiating surface. Each unit is equipped with a conservator tank. The operating mechanism for the Regulating Transformer is enclosed in a weatherproof housing mounted on the side of the tank and supported by an extension of the base. The main transformers weigh 47½ tons each and the Regulating Transformer 34 tons.

44,000 Volt Equipment

The two 44,000 volt feeders are each controlled by a Type "GA-3B" oil circuit breaker manufactured by the Canadian Westinghouse Company. A 50,000-25,000/125 volt potential transformer is installed on each of these feeders to provide facilities for synchronizing with the 44,000 volt bus. Two 50,000/125-125 volt potential transformers are connected in open delta to this bus. All four potential transformers were manufactured by the Packard Electric Company. A 50,000 volt type "OF" lightning arrester, manufactured by the Canadian General Electric Company, is connected to the 44,000 volt bus thus affording lightning protection for the lines which connect to the St. Lawrence and Central Ontario Systems.

Protective Equipment

The transformer bank is protected by relays differentially connected to bushing type current transformers on the breakers controlling the incoming 110,000 volt line and the two 44,000 volt outgoing lines. Overload relays connected to bushing type current transformers on the 110,000 volt breaker provide a secondary system of protection for the station. The feeder supplying the Central Ontario System is protected by a directional residual ground relay so connected as to trip only on outgoing fault current. The St. Lawrence feeder is equipped with standard non-directional ground and overload protection.

General

Construction was commenced on August 1st, 1928, and was substantially complete ready for service on October 1st, 1928. An Operator's house is now being erected on the station site. All construction work was carried out by the Commission's Construction staff.

New 44,000 Volt Switching Station at Kingston

A 44,000 volt switching station has been constructed at Kingston to provide synchronizing and automatic sectionalizing facilities at this point for the inter-connection of the Central Ontario System and Ontario-Eastern System.

This station is adjacent to Kingston Distributing Station. Its structure is constructed of 2-inch galvanized steel pipe. All equipment foundations are of concrete. There are two incoming 44 kv. feeders, one from the Central Ontario System and the other from the Ontario-Eastern System. Each of these feeders is controlled by a Type "GA-3B" oil circuit breaker manufactured by the Canadian Westinghouse Company. The connection for Kingston Distributing Station is made directly to the east end of the bus of this station. A potential transformer is installed on each of the

two incoming feeders to provide synchronizing facilities. Three more potential transformers are connected to the bus. Their primaries are connected in star with the neutral grounded and their secondaries are connected in delta with one corner open to provide residual voltage for directional ground relays. All five potential transformers are rated 50,-000/125-125 volts and were manufactured by the Packard Electric Company. Bushing type current transformers installed in the oil circuit breakers furnish the current for the directional relays.

The switchboard and storage battery for the control of this switching station are installed near the switchboard and control room of the distributing station.

The construction of this station was carried out by the Commission's Construction Department. Work was commenced early in October, 1928, and was completed by November 1st, 1928.

Electrolysis and its Mitigation

By W. B. Buchanan, Testing Engineer, H.E.P.C. of Ont.

(Read before the Canadian Section, American Water Works Association.)

CORROSION of pipes can occur without any extraneous source of potential. We find that the chemical action between an acid bath and a metal immersed in it gives rise to an electric potential, the value of the potential being different for different metals. Hence, if we were to set up an electrolytic cell consisting of two dissimilar metals in an acid bath and close the external circuit we would get a flow of current and this would be in effect a primary battery. The value of voltage and current available would vary with the character of the metals, the kind of acid, its concentration and the resistance of the circuit.

Hence a study of the susceptibility of a given installation to electrolysis from local action can best be made by testing for acid and its quantity in the soil and by a careful inspection of conditions quite local. Corrosion may occur at the junction of two pipes of dissimilar metals due to this local action or it may also occur on a single piece of metal pipe which contains impurities.

Effects of Stray Currents

The more difficult type of problem, however, from the standpoint of the mitigation of electrolysis is that arising from the effect of stray ground currents, as the source of such currents may be miles distant and the paths offered to the flow of current may be quite complicated. Moreover, co-operation is required on the part of all parties making use of underground locations for equipment in order that the least hazardous scheme of connection may be adopted.

It seems difficult to formulate rules for installation which would be beneficial in all cases, and I believe this

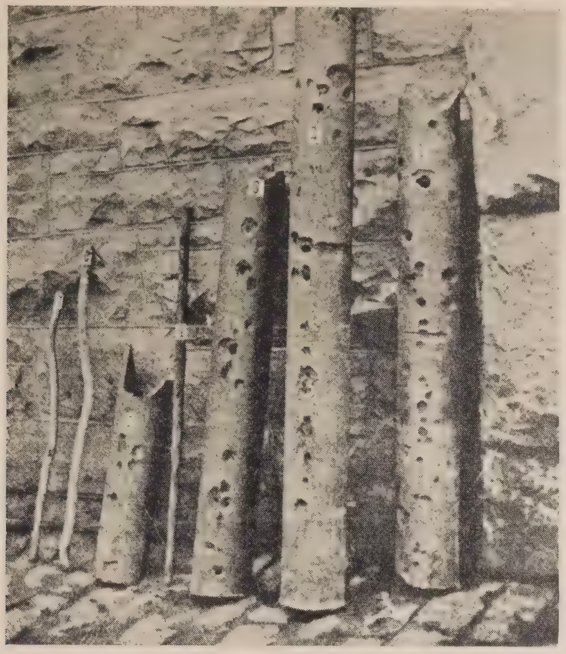


Fig. 1.—What electrolysis does to water mains.

difficulty has been shown in practice. The problem is simplified, however, by one fact, that in the case of electrolysis from stray direct current, the corrosion takes place where the current leaves the metal and passes into the liquid or wet earth. This aids in working out a satisfactory scheme of bonding or not bonding as may be dictated by the results of suitable tests.

Fig. 2 illustrates in the most simple manner what may occur throughout the circuits. Current is fed from the supply station over the feeder and trolley wire to the street car and thence to the rails. Here it spreads out through the ground, through service pipes to water mains and any other conducting channels it may find to the negative bus. If two paths of non-uniform resistance are parallel to each other for a distance, say, of one-half mile with fairly good insulation between them, there may be an interchange of currents at the ends such as indicated between the rail return and the water-mains. Electrolysis of the

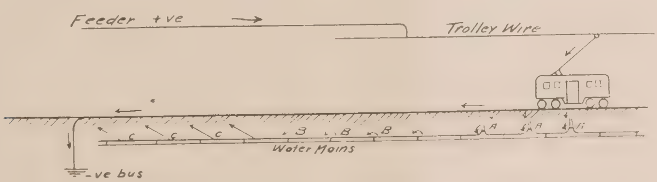


Fig. 2.—Current distribution through ground return.

watermain may take place at A where the lead service pipes are attached to the watermains, at B where a joint in the mains of fairly high electrical resistance causes the current to leave one pipe through the moisture of the soil, and at C where the current must leave the pipe system through soil or water to reach the negative bus.

Analyzing Electrolysis Conditions

Lest anyone should jump to the conclusion that the problem of a survey and its analysis is a simple problem I would draw attention to several statements in the Manual of Water Works Practice. On page 420 it is stated: "It is important that electrolysis investigations of any importance be made under the direction of a competent engineer very familiar with methods of procedure and the analysis of test data." Again on page 421 under section 3 (b): "These measurements afford the most valuable index of electrolysis conditions but unfortunately they are the most difficult to secure and unless taken by a competent engineer thoroughly familiar with the possible sources of error involved, they may be worthless or actually misleading."

Obviously the Manual is not intended to be an exhaustive treatise on electrolysis but certain steps are outlined and many helpful suggestions offered for the guidance of the engineer directing an investigation. While we will probably all admit that an engineer with wide experience on such work is desirable, other things being equal, it is generally necessary to use such talent as may be available. The problem is essentially investigational in type and must be worked out step by step. The following general scheme is suggested.

Survey Procedure

The first steps to take in any general survey would logically be to obtain a plan of all equipment underground which could act as conductors. These include railway track and return feeders, gas and water piping, cable sheaths and building structures. Complete data may be difficult to obtain. For instance, we have learned during the progress of a survey of the presence of a pipe line which had been abandoned twenty years or more ago and of which the records, if there ever were any, had been lost. In such cases the memory of older residents of the locality may be of assistance.

The origin of such stray currents as may be present must be located. Where there is only one source in the district this may be suspected but it does not follow necessarily that electrolytic corrosion is taking place. A system of tests must then be planned to indicate definitely the presence, direction and magnitude of current in such underground conductors or sections of them as may be accessible. Potential difference tests are more easily made than current measurements and many such will have to be made between such points as railway track and hydrant, track and service pipe; in fact, between any points where a potential difference may be suspected. Collecting and co-relating these results gives the engineer a clue as to the general direction of ground currents provided that they represent simultaneous values, which in general they do not. Values may be obtained from

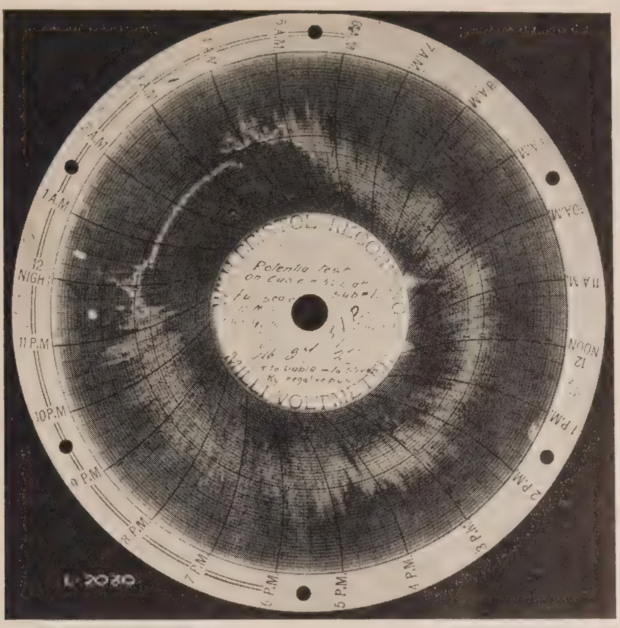


Fig. 3.—One form of recording the variation in d.c. load in an electrolysis investigation.

a few millivolts to one hundred volts or more where conditions are bad. The current flowing in such pipes or cables as it is particularly desired to protect may be measured by methods which have been developed especially for the purpose. Such readings must be carefully co-ordinated with simultaneous readings of voltage as previously noted.

Stray currents from street railways are extremely variable in value and it is impossible to obtain simultaneous readings of currents and voltages. The best approximations available may be found by such a scheme as the following. A graphic meter, voltmeter or ammeter, may be set up in the district in which measurements are being made, thus obtaining a record of the variation of the d.c. load throughout the day. Figs. 3 and 4 illustrate two types of records. The time interval of the traffic should be noted as indicated approximately by the chart, *e.g.*, ten, fifteen minutes, etc. This interval should be used for each measurement; for example, any voltage reading on a ten-minute traffic should be watched ten minutes and the maximum and minimum values noted together with an average value if it should differ materially from the mean of the two readings.

With the data obtained from a preliminary survey such as the above the engineer is able to make a plan drawing of his system noting thereon the magnitude and direction of the current flow. The results of a careful study of the data will then indicate where bonding should be resorted to

and where it should be avoided. As a general principle I would submit that the best of drainage out from the pipe line should be provided but no feed into the pipe at remote ends that can be avoided. A desirable feature would seem to be that the potential of pipe lines should be kept below that of the railway track at any point to avoid any possibility of swapping currents at any other than bonding points. Any tendency for direct current to flow from an iron pipe to the soil creates a hazard due to possible electrolysis. This dictates the use of conducting joints in the pipes and solidly bonding to the negative railway bus.

Such a condition should not be difficult to obtain where there is only one railway sub-station or one negative bus which can be taken as the point of lowest potential to which all other points must be drained. If any radical change in conductivity of the underground properties be made as the result of a first survey, then a new survey would be necessary to determine the effect of the change, as the conditions are usually too complex and the data too meagre for calculation.

The problem becomes more intricate when two or more sub-stations are involved or where two or more railway systems swap currents at points miles apart. The former are likely to be provided with some method of bonding the negative feeders together, whereas in the latter type there may be no attempt to control the current which is transferred between systems through

Fig. 4.—Another form of chart valuable in stray current studies.

grounds and which might give rise to most pernicious conditions. Further, the variation in load demand throughout the day may not follow the same general sequence and this leads to reversal of current flow and potential differences at different periods and sometimes even within a few minutes. In such cases it may be advisable to use meters, either indicating or graphic, which will give readings on both sides of the zero line and of course polarities must always be noted and recorded.

A survey which indicates reversal of flow of current in pipe lines may indicate the advisability of bonding solidly to the railway track or negative bus at more than one point. It is hardly to be expected that such a practice would always give perfect freedom from hazard due to electrolysis, but test data should be obtained which would enable such connections to be made as would reduce the hazard to a minimum.

Conductivity in the Joints

The need of good conductivity in the joints of pipe lines has been mentioned but it should be emphasized. If the potential drop across the joint due to the flow of stray direct current exceeds a fraction of a volt, part of this current will be shunted by the soil which is in contact with the adjacent ends of the two pipes. The amount of current, of course, depends on the electrical resistance of the soil as well as the difference in potential but any tendency whatever to shunting of current in this manner is hazardous and should be avoided.

Cross-overs between service pipes and gas mains where appreciable differences in potential may exist also present hazards. The survey may show that these pipes should be bonded together.

Another critical point is the joint between the service pipe and the water main at the consumer's premises. The contact surface between lead and iron may develop sufficient resistance to force any current to leave either pipe by way of the soil and enter the other pipe.

Meters and Measurements

With this perspective of the problem a few remarks as to meters and measurements may be useful. We have a miniature model permanent magnet type of instrument with six scales, 1.5, 15 and 150 volts and 1.5, 3 and 30 amperes, that we have found very convenient. This meter may be used when reversal of voltage occurs by adding a small double-throw switch and is more compact than an indicating meter having positive and negative scales of the same degree of sensitivity. It may be necessary to use very long leads in order to obtain the voltages required and we have had occasion to run special wiring one thousand feet or more. It may be possible in some cases to make use of existing conductors if proper arrangements can be made.

Current measurements, as a rule, offer the greatest difficulty as it is not often possible to open the circuit to insert an ammeter for direct reading. On one occasion I measured 23 amperes flowing in the lead sheath of a 13,000-volt cable. This sheath was carrying current from one railway track to the negative bus of a neighboring railway system and the sheath

was well bonded at the latter end. This treatment seems to have been effective as we have no record of trouble due to electrolysis on this cable after eight years of service. A satisfactory method of measuring the current in any pipe or conductor has been developed and a continuous graphic record may be obtained with a millivoltmeter. (See Methods of Measuring Electrical Resistance, by Northup, page 110). The connection uses the pipe itself as a shunt to the meter and the method of calibration suggested guarantees a fair degree of accuracy in the results. In some cases, especially in preliminary work, it may be quite satisfactory to obtain by test or record a fair average value of pipe resistance and thus obtain a constant by which the millivolts read may be converted to amperes. Great precision in the measurement of current should not be expected and an accuracy of one per cent would not generally be of any value even if it could be obtained with assurance.

Association of Municipal Electrical Utilities

PRIMARY BALLOT

The report of the scrutineers giving the results of the Primary Ballot shows the following nominated as candidates for the various offices for the year 1928—

President—
A. W. J. Stewart, J. G. Archibald

Vice-President—
H. G. Hall, J. G. Jackson *, O. M. Perry *

Secretary—
S. R. A. Clement

Treasurer—
D. J. McAuley, G J. Mickler

Directors—(From the membership at large)—
O. H. Scott, V. S. McIntyre, J. E. B. Phelps, W. R. Catton, E. V. Buchanan, P. B. Yates

District Directors—
Niagara District— J. E. Teckoe, J. W. Peart.
Georgian Bay District—J. R. McLinden, E. J. Stapleton,
Central District— W. E. Reesor, J. E. Skidmore.
Northern District—T. W. Brackinreid.
Eastern District—A. L. Farquharson, R. J. Smith.

*Tie.

The above names, subject to the wishes of the nominees, will appear on the election ballot; the election taking place at the Winter Convention to be held at Toronto on January 23 and 24, 1929.

Application of Hydro-Electric Power to Farm Work

Article No. 17

Threshing Grain

THRESHING grain on Ontario farms is to-day a serious consideration by many thinking farmers as shortage of help during harvest season has created a desire on the part of many to thresh from the field. Others have been doing this for many years and we find in some parts of the country a great variety of threshing machines varying from the very old types without windstackers. A few were without any delivery arrangement excepting gravity, the straw falling from the end of the threshing decks, thus requiring handling and necessitating extra help. The convenience of electric power drives on farms has brought a host of requests to the Commission for information regarding this application.

The Wagner Electric and Manufacturing Company in co-operation with the Hergott Manufacturing Company of Mildmay and the John Goodison Manufacturing Company of Sarnia assisted by the Commission's Engineers arranged for tests on the 22 in. by 38 in. machine of each make. Tests were also made on an old New Hamburg machine, 28 in. by 44 in., on a farm in the Baden district.

The results of these tests are submitted below with general observations. Another test using the Waterloo Manufacturing Company's machine is to be run about the end of November, results of which will probably be submitted later.

GENERAL OBSERVATIONS

1. The power required for actual work of threshing is small (about 4 to 5 horsepower), the balance of that taken being used to supply losses such as friction in bearings, driving belts and windage.

2. Speeds recommended by the manufacturers are too high resulting in excessive losses, plugging in the cylinder, frequent feed table stoppages and probably the carrying of some grain over with the straw.

RESULTS OF TESTS ON NO. 3 MACHINE TO FIND POWER TAKEN BY WINDSTACKER AT DIFFERENT SPEEDS:

SPEED	POWER REQUIRED	OBSERVATIONS
875	13.5 h.p.	Standard equipment, excessive amount of air.
658	6.7 h.p.	More air than necessary.
600	4.4 h.p.	Excellent operation
435	2.3 h.p.	Fair operation

These tests were made on a blower with a 13 in. pipe. If a 10 in. pipe were used the slow speed of 435 would have delivered straw as far as the 875 speed and 10.8 horsepower could have been saved.

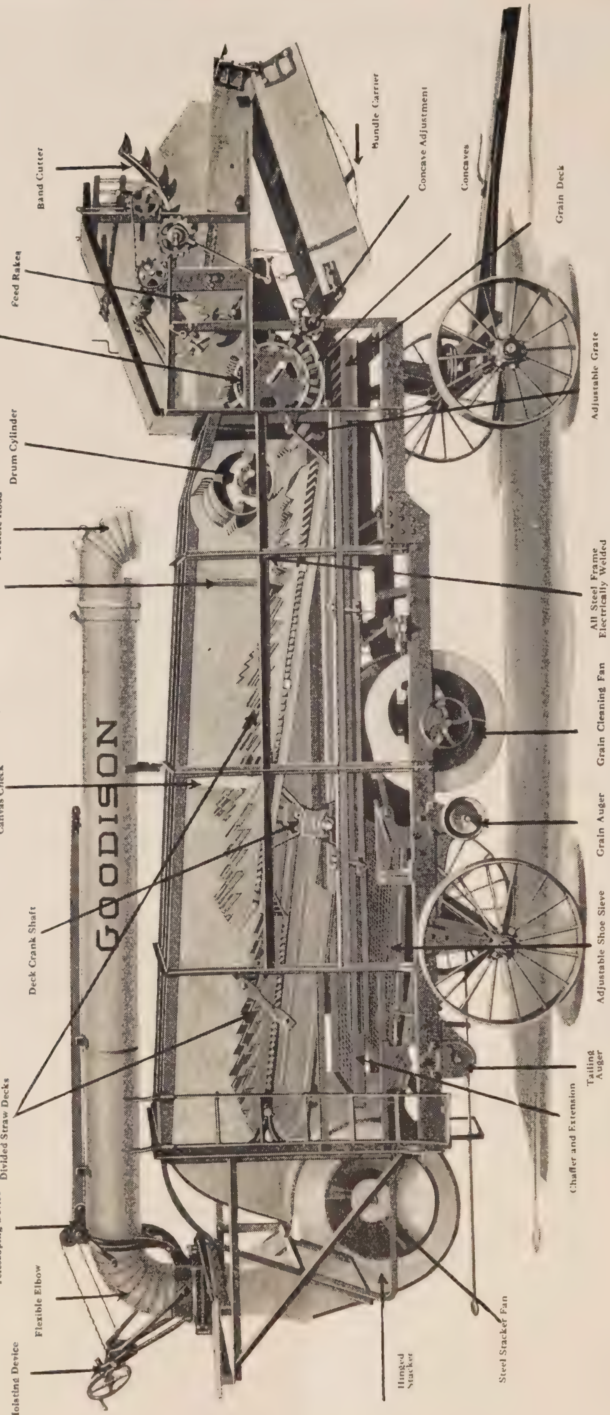


Fig. 1.—Cross section through threshing machine, which clearly indicates the parts of a modern machine. The arrows and naming of the parts suggests the work of each unit and gives an idea of the process of grain separation as done by present day machines, either individual or those doing customs work. There are of course some differences between the machines of the various manufacturers.

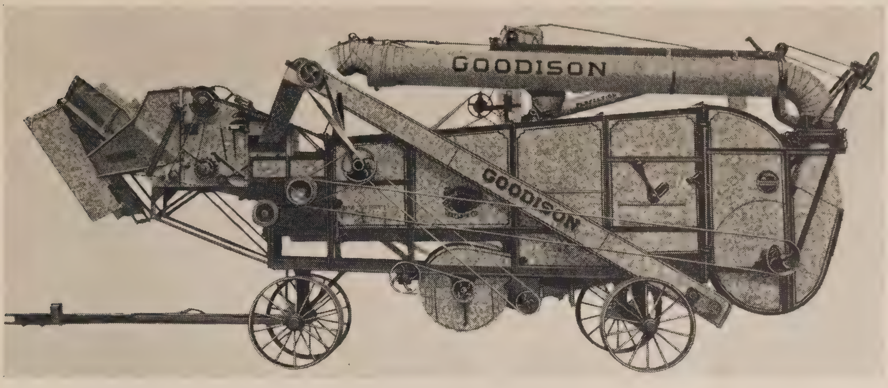


Fig.—2.—The main drive side of the 22 in. by 38 in. machine, with all steel frame and body. It has been suggested that improvements might be made in some of the drives by using roller chain and sprockets or V pulleys and V belts on a few where the centres are short and the power required small. Improvements in the windstacker by lowering the speed and decreasing the size of the windstacker pipe would permit the use of a smaller belt. This form of drive through the drum cylinder to other parts seems to be universal by most manufacturers.

Note the short drive centres at the bottom driving the grain deck, and at the front and top to the drum cylinder from which originates the drives for other parts and to the tailings elevator.

RESULTS OF TEST ON NO. 1 MACHINE WITHOUT WINDSTACKER AT VARIOUS CYLINDER SPEEDS:

Cylinder Speed	Power Required
1100 rev. per min.	12.4 h.p. Not threshing
1020 " " "	10.0 " " "
940 " " "	5.9 " " "

NOTE:—7.9% increased speed requires 24% additional power.

WORK DONE FROM TEST ON NO. 1 MACHINE:

Cylinder Speed	Output
900 rev. per min.	70 bushels of oats per hour
1100 " " "	40 " " " " "

At the higher speed there were frequent table stoppages due to plugging and it is probable that there was grain being carried over in the straw.

DISTRIBUTION OF POWER TAKEN—PROPORTIONS ESTIMATED —THE TOTAL BEING METERED FROM TEST ON NO. 1

Speed of cylinder—940 rev. per min. Speed of windstacker—625 rev. per min.

PART	BEARINGS LOSS	BELTS LOSS	WINDAGE	TOTAL LOSSES	WORK DONE
Cylinder and Main Belt	.3	1.0	.5	1.8	2.2
Feed Table, Band Cutter, Feed Rake	.4	.4	.2	1.0	.7
Drum Cylinder	.2	1.0	.2	1.4	.7
Decks	.3	.2	0	.5	.3
Grain Cleaner Fan	.1	.1	.5	.7	0
Grain Auger, " Elevator	.2	.1	0	.3	.3
Tailings Elevator and Auger	.1	.1	0	.2	.2
Total without windstacker	1.6	2.9	1.4	5.9	4.4
Windstacker	.2	.2	2.8	3.2	0
	1.8	3.1	4.2	9.1	4.4

Total Power—9.1 (losses) + 4.4 (work) = 13.5 h.p.

At—Increased speed (1100) on cylinder
(730) on windstacker

BEARINGS LOSS	BELTS LOSS	WINDAGE	TOTAL LOSSES	WORK DONE
2.0	3.6	6.8	12.4 h.p.	4.4

Total Power—12.4 + 4.4 = 16.8 h.p.

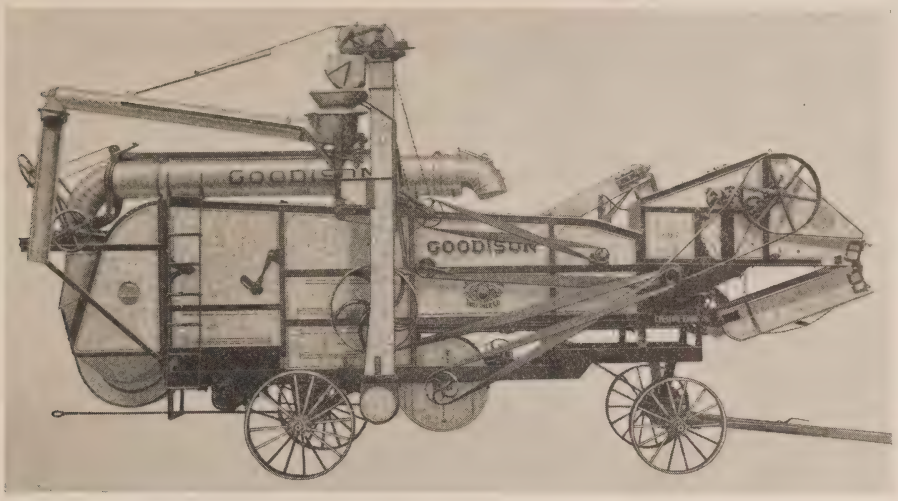


Fig. 3.—The grain delivery side of the machine. Note again the crossed belt drives with small drive pulleys and tightener. It has been suggested that corrections be made to avoid crossed belts if possible.

3. The windstacker of many machines requires more power than the rest of the machine, due to the use of too large a discharge pipe necessitating the handling of a large volume of air in order to have the necessary velocity to deliver the straw.

4. Belting losses are too high, caused by tight and crossed belts on drives with short centres.

5. Excessive bearing friction in some cases due to bending shafts in bearings where the drives are on short centres and belts tight.

6. New machines require about double the power until run-in.

At the higher speed there were frequent table stoppages due to plugging and it is probable that there was grain being carried over in the straw.

Summary

It is to be noted from the tabulation of the distribution of power that savings can be effected in belting and windage losses. The use of roller chain and sprockets as a substitute for the present belts and pulleys on short drives should reduce the bearing and belt losses by 1 to 2 horsepower, and the use of a small pipe on the windstacker would allow a speed reduction from 600 rev. per min. to about 400, and save about 1 to 1½ h.p. more, making the total power required between 10 and 11 horsepower—input—when threshing 70 bushels of oats per hour with average grain.

The use of ball bearings would not materially reduce the power as long as the plain bearings are in line and well lubricated. Lack of lubrication on plain bearings will result in excessive losses. On our test a bearing ran dry and increased the load over 2½ h.p. The use of ball bearings would tend to retain easy running over a period of years and reduce the attention necessary.

Why not an Electro-Chemical Industry

By A. S. L. Barnes

UNDER the above heading the *Electrical News* of May 1 this year contained an editorial which was inspired by an article in the same issue, an abstract of a paper on "Electricity and the Chemical Industries," which had been read some little time previously by Sir Alexander Gibb before the Institution of Chemical Engineers in England. There are, of course, in operation in Canada today several electro-chemical and electro-metallurgical works of considerable importance, of which the Province of Quebec has the largest share. The editorial mentioned above was chiefly concerned with one particular section of the electro-chemical industry, *viz*: the synthesis of ammonia, which comes under the general term "nitrogen fixation."

Nitrogen fixation, for reasons which will be given later, is not of so much direct interest to the electrical engineer now as it was some years ago, before the synthetic ammonia process occupied its present important position. In Canada, however, much of its interest remains, especially in Ontario and Quebec—owing to the presence of abundant water power and the lack of coal. The synthetic ammonia process, if established in these provinces, would almost certainly be supplied with hydrogen obtained electrolytically. This would result in much more electrical power and energy being required than would otherwise be the case.

Some Commercial Uses of Nitrogen

Nitrogen, in combination with other substances, is used in many industries of which the manufacture of dyes, nitro-cellulose lacquers (*e.g.*, Duco varnish), artificial silk, explosives and fertilizers, are today the most important.

For those who are not conversant with the subject of nitrogen fixation, the following may be of interest: Nitrogen we know forms four-fifths of the air we breathe; in chemical combination with other substances it forms an essential constitutent of the structure and bodies of all living things on this earth, plants and animals alike, and while plants obtain their nitrogen either from the soil or from the atmosphere through the agency of bacteria, all other creatures obtain their nitrogen either through feeding on plants or on animals, or both. Besides, being an essential to all forms of life, nitrogen is, paradoxically, essential to nearly all kinds of those materials (explosives) with which man is accustomed, in war time, to destroy life.

Nitrogen, being a constitutent of plant life is found in coal and is recoverable from that material, in the manufacture of coal-gas and coke, in the form of ammonia. It is usually combined, at gas and coke works, with sulphuric acid to form ammonium sulphate which is an excellent fertilizer. Nitrogen is also present in the deserts of northern Chile where

vast quantities of rock, lying only two or three feet below the surface, yield, with suitable treatment, the well known Chilean nitrate of soda which is also a good fertilizer.

These two sources of nitrogen were, until about 20 or 25 years ago, the only sources of "fixed" (or chemically combined) nitrogen, of any importance, in the world.

Nitrogen Fixation

"Nitrogen fixation" is a term applied to artificial means for combining the nitrogen of the air with other substances so that use may be made of it. It may be here remarked that gaseous nitrogen uncombined with any other elements or compounds is of very little value to man at the present time; its use in electric lamps and transformers is, relatively, insignificant.

The history of the nitrogen fixation industry is not unlike that of the world, in which "kingdoms rise and wane."

The Arc Process

For many years the arc process held sway and was especially successful in Norway where large amounts of very cheap hydro-electric power gave it an advantage which was not readily available elsewhere. In this process air is blown through an electric arc and some of the oxygen combines with some of the nitrogen to form nitric oxide (NO) which is then cooled rapidly and mixed with more air, this results in the formation of nitrogen peroxide (NO_2). The nitrogen peroxide is then passed upwards through huge towers down which water is trickling; this produces nitric acid, which may be sold as such or may be combined with other materials to form nitrate of lime, ammonia, nitrate of ammonia, etc. The arc process is very inefficient and all efforts to improve it in this respect have, so far, failed to produce any commercially satisfactory result.

From the standpoint of the electrical engineer it is unfortunate that this process could not be more generally adopted throughout the world than it is. The process is simple, labor cost is relatively low and it is capable of intermittent (off-peak) operation but, for commercial success, a large plant requiring a very large amount of very cheap power is essential.

The Cyanamide Process

The calcium cyanamide process is the next one to be considered. In this process nitrogen is blown through steel drums containing hot calcium carbide, the reaction being $CaC_2 + N_2 = CaCN_2 + C$. Each drum has a carbon rod through its centre and around this rod is packed the carbide; current is passed through the carbon rod, thus heating the carbide and nitrogen is blown through the drum. The reaction is exothermic after it is once started so that the current can be shut off and the process continues automatically until it is completed.

Calcium cyanamide is itself a fairly good fertilizer and has been extensively used, especially for cotton growing, but it has some undesirable characteristics and has within recent years been used as a starting point for the manufacture of other nitrogenous fertilizers and materials. The nitrogen required for the process is obtained by liquefying air and boiling

it off, the oxygen being usually wasted. This process is in operation in Canada at the works of the American Cyanamide Company, Niagara Falls, Ont.; it is the only branch of the nitrogen fixation industry at present established in this country.

The Synthetic Ammonia Process

The third, and now by far the most important, of the nitrogen fixation processes, is the synthetic ammonia industry, the history of which forms one of the most remarkable instances of the value of scientific research.

The synthetic ammonia process consists, essentially, in combining nitrogen and hydrogen chemically. This is accomplished, commercially, in the presence of a catalyst, at high temperature and under great pressure. Certain chemical reactions will not take place unless there is present some element or compound (to which the name catalyst has been applied) which, while in no way entering into the chemical reaction which it is desired to bring about, is, nevertheless absolutely essential. For any given purpose some catalysts are better than others in that they accelerate this reaction and in that the period of their effectiveness is of longer duration; also some are much less costly than others. For these reasons extensive research has been carried on in connection with catalysts for various chemical processes in order to obtain the desired characteristics at the lowest cost. The particular catalyst used in any process is usually kept secret as it is in many cases the key to the success of the process.

Variants of the Synthetic Ammonia Process

There are several variants of the synthetic ammonia process—the essential features are the same in all but they differ in certain details. The variants are:

1. The Haber process developed and used in Germany.
2. The modified Haber process developed and used in England.
3. The Claude process developed and used in France and employed in various other countries.
4. The Casale process developed and used in Italy and employed in various other countries.
5. The Fauser process developed and used in Italy and a few other countries.
6. The "American" process developed by the Fixed Nitrogen Research Laboratory of the United States and used in that country.
7. The Mont Cenis process being developed in Germany. This last is said to use a more efficient catalyst than any of the others and to give a considerably increased yield although much lower temperature and pressure are employed.

As a matter of fact, since the Haber process is the forerunner of all these others, and the underlying principles of all are the same, it may be said that they are all "modified Haber" processes.

Development of the Synthetic Ammonia Process in Various Countries

As might be expected, Germany leads all other countries in her development of the synthetic ammonia (Haber) process. In that country about 600,000 tons of the

nitrogen of the air are being fixed annually and this quantity is increasing rapidly. Most of this enormous tonnage is turned out by the synthetic ammonia process and by far the greater part goes into the manufacture of fertilizers.

Until about six years ago the artificial nitrogenous fertilizer market was dominated by Chilean nitrate of soda; the Nitrate Producers Association fixed the prices for the coming year and the price of by-product (gas works) sulphate of ammonia, nitrate of lime, calcium cyanamide, etc., were, perforce, regulated accordingly. This situation is now completely changed. Two years ago the Chilean nitrate situation was so desperate that the producers, one after another, closed down their plants until from there being about 92 in operation only about 27 remained active. There is an export tax on Chilean nitrate and the trade is, or was, of such importance that this tax provided the Chilean government with about half of its total annual revenue; the nitrate producers asked the government to relieve them of at least a portion of this tax but the government refused, although it is assisting in other ways, and the producers are now modernizing their plants and methods as the only means of saving themselves from complete extinction.

In addition to this almost complete disorganization of the Chilean nitrate industry the by-product ammonia industry has also been so seriously affected that gas-works ammonia has been almost reduced to the status of a waste product, a position which it held in the early days of the gas industry, before its value was appreciated and before any market for it had been built up.

The reason for this great change is, simply, that in recent years the synthetic ammonia process has been successfully developed and a huge industry built up. The synthetic product is both cheaper and better than the ammonia by-product of the gas and coke works. Moreover, nitrogen "fixed" by this process is cheap enough to permit of the commercial conversion of the ammonia into other nitrogen compounds, *e.g.*, into nitric acid by combining it with oxygen.

The demand for fixed nitrogen throughout the world is increasing by about 100,000 tons per year, the total demand at present being about 1,500,000 tons.

The data already given will serve to show how important the synthetic ammonia process now is as a world industry. Among other things, some observations on the possibility of its establishment in Canada will be given in the next section of this article, more especially from the point of view of the electrical engineer.

In the former section of this article, the phenomenally rapid growth of the synthetic ammonia industry was indicated, and the statement was made that the direct interest of the electrical engineer in nitrogen fixation is not now so great as formerly. Table I shows the reason for this diminished interest.

Energy Requirements for Synthetic Ammonia Process

The aggregate capacity of the synthetic ammonia plants of the world far exceeds that of the arc and cyanamide plants combined—the ratio is, or soon will be, about 3½ to

TABLE I.—ENERGY TO FIX NITROGEN

Process	Approximate kw-hrs. required per ton of nitrogen fixed
Arc	61,000
Cyanamide	14,000
Synthetic Ammonia	
Hydrogen obtained electrolytically	16,000
Hydrogen obtained by chemical means	4,000

1, and the aggregate capacity of the synthetic ammonia plants which obtain their hydrogen chemically is much greater than that of those which obtain it electrolytically. It is evident, therefore, that the total amount of electric power utilized in the nitrogen fixation industry to-day is only a fraction of what it might be if all the nitrogen were being fixed by the arc, or even by the cyanamide process.

It is, however, true that the aggregate capacity of the synthetic ammonia plants which obtain their hydrogen electrolytically is about 100,000 tons of nitrogen (fixed) per annum, of which Italy has 47,000 and Japan 40,000; the other countries being the United States, Spain, Switzerland and Sweden, with plants of very small capacity.

The energy required for the fixation of 100,000 tons of nitrogen, including that required for obtaining the necessary hydrogen electrolytically, is about 1,600,000,000 kw-hr., which,

TABLE II.—SYNTHETIC AMMONIA PLANTS IN OPERATION OR UNDER CONSTRUCTION IN 1927

Country	No. of Plants	Approximate Aggregate Capacity in Tons of Nitrogen per Annum.		Total Aggregate Capacity Tons of Nitrogen per Annum
		In Operation	Under Construction	
Germany	3	500,000	300,000‡	800,000
France	14	55,000	92,000	147,000
England	2	20,500	55,100	75,600
United States	9	24,800	35,900	60,700
Italy	8	57,400	18,000	75,400
Japan	3	41,600	12,600	54,200
Belgium	4	11,000	17,500	28,500
Six other Countries	8	11,800	22,500	34,300
TOTAL	51	722,100	553,600	1,275,700

‡ 1928.

at 100 per cent. load factor, represents over 180,000 kilowatts. The plants in Italy, must, therefore, require about 80,000 and those of Japan approximately 72,000 kilowatts.

Table II shows where the greatest development of the synthetic ammonia industry has taken place. New plants are being built and existing ones are being enlarged.

In Italy, probably, even more than this amount of power is required, since in some, at least, of her plants the nitrogen required is obtained by burning hydrogen in air, whereby water is formed, nitrogen being left.

Where this is done, more hydrogen, and therefore more electric power, will be needed than is represented by the 16,000 kw-hr. shown in Table I.

Much the greater part of the nitrogen fixed throughout the world by the synthetic ammonia process is fixed at plants where the necessary hydrogen is obtained by passing steam over hot coal or coke ($CO + H_2O = H_2 + CO_2$) and the electric power requirement is relatively small. Many of these plants are established right at the coal mines. Other chemical methods of obtaining hydrogen are also in use. Some plants utilize hydrogen which is a by-product of another industry—in such cases, the capacity of the synthetic ammonia plant is limited by the quantity of hydrogen available.

Cost of Hydrogen Important

The question of hydrogen supply is a very important one in the synthetic ammonia process, as, under normal conditions, its cost is probably about 50 per cent. or more of the total cost of the process.

The cost of electrolytic hydrogen naturally depends, to some extent, on the possibility of finding a market for the oxygen. It has been found to be commercially practicable to oxidise synthetic ammonia to nitric acid and some of the oxygen can be utilized for the manufacture of this acid, which is one of the basic materials of industry. It should be possible to find other commercial uses for by-product electrolytic oxygen, and every advance in this direction would lower the cost of the hydrogen.

If hydrogen be obtained chemically, the amount of electrical energy required by the synthetic ammonia process is relatively small, being only that required for pumps, compressors, lighting, etc.

Use of Off-Peak Power

In considering the generation of oxygen and hydrogen by electrolysis, the question of utilizing off-peak power always comes up. It is claimed that electrolytic cells for this purpose are capable of carrying heavy overloads without injury, although with some loss of efficiency. Again, the current may be turned on and off at a moment's notice without difficulty. These facts make the possibility of using off-peak power for water electrolysis look very attractive, and so it is, merely from the point of view of power.

It must be remembered, however, that, with great variations in the output of the electrolytic cells the capital cost of plant other than the cells will be relatively heavy, because of the need for increased capacity—there would also, in all probability, be need for storage facilities for the gases; also deterioration of the cells would probably be more rapid under overload conditions.

Nitrogen Fixation in Canada

It was stated in the former section of this article that there is in Canada, at present, only one nitrogen fixation plant—that of the American Cyanamide Co., at Niagara Falls, Ontario. This plant was established in 1908. Many experts have expressed the opinion that it is unlikely, owing to the position now occupied by the synthetic ammonia process, that any new cyanamide plants will be built. Even the great plant in Norway, which utilizes what is probably the cheapest water-power in the world, is being changed over to the synthetic ammonia process.

Establishment in Canada of the Nitrogen Fixation Industry

The question of establishing a nitrogen fixation industry in Canada needs very careful consideration. First and foremost is, perhaps, the matter of markets. If a large market for any given commodity exists, there is a chance for a new product to establish itself fairly quickly if it has the advantage of lower price or better quality or both, but if it be a matter of creating a market or of increasing an existing small one, the process is likely to be slow, unless definite, active steps are taken, by advertising in one way or another, to accelerate it.

In this connection, and with special reference to fertilizers, Col. Pollitt of British Synthetic Ammonia and Nitrates Ltd., made the following statement in an address last May: "In general, it is not worth while considering the creation of local factories until there is an assured home market for a sufficient tonnage to justify a separate works. The preliminary testing of the market, research into the best types of fertilizers for the particular condition of the country and the education of the farmer, are best carried out by means of imports." Later on in the same address he adds: "But the new processes are so expensive in capital costs that the greatest care should be exercised in deciding on the size and design of a plant before going in for the large expenditures involved."

In view of the present status of the three great nitrogen fixation processes to which attention has been drawn in this article—the only ones, out of many, that have been established on a large commercial basis—it appears that the synthetic ammonia process is the one that should be considered. Among the various modifications of this process it will probably be found that one is better suited to certain local conditions than any of the others. For example, it may be necessary, for certain reasons, to consider the use of several plants of moderate size installed at various points rather than one very large plant. Such necessity might exist where electric power for the production of hydrogen was available in relatively small amounts at several points, or where, as, perhaps, in Western Canada, the development of a local market might be possible, but where transportation costs were a bar to the ready building up of more distant markets.

Again, while in Ontario and Quebec it would seem natural to consider obtaining hydrogen electrolytically, in Alberta and Saskatchewan the use of coal and lignites would certainly

come under review for the production of hydrogen by the water-gas process.

Complete Chemical Fertilisers

The most recent development in the manufacture of fertilisers is the production of materials containing, in chemically combined form, nitrogen and phosphorus, or nitrogen, phosphorus and potassium. Studies are being made of the actual needs of various countries, and the proportions of these constituents are varied to suit those needs.

Germany and England are believed to be the only countries exporting any considerable amount of artificial nitrogenous fertilisers and the two great chemical combines—Interessen Gemeinschaft Farbenindustrie A-G., and Imperial Chemical Industries Ltd., respectively—(known as the "I.G." and the "I.C.I.") are conducting research, not only within the confines of their own countries but also abroad The I.C.I. for example, is investigating conditions in India, China, Brazil, South Africa and several other countries, with a view to developing markets.

Use of Fertilisers

As indicating what the possibilities of the use of fertilisers might accomplish in Canada, the figures in Table III are of interest. These (except those for Canada and the U.S.) were selected from a table given in an address delivered by F. C. O. Speyer at the International Nitrogen Conference held last May on board ship on the Adriatic Sea.

These figures indicate that, in Western Canada, instead of a "bumper" crop of 550,500,000 bushels which, it has been estimated by the

TABLE III.—AVERAGE YIELD OF WHEAT

Country	Average Yield of Wheat Bushels per acre (3 years 1924-1926 inclusive)
Denmark	41.2
Netherlands	41.0
Belgium	38.1
Great Britain	32.7
Germany	26.5
France	20.8
Canada	17.5
Jugoslavia	16.2
United States	14.1
Rumania	11.8

Government, is being harvested this year, this quantity, huge though it is, would, on the basis of Denmark's average for three years, have been about 1,305,000,000 bushels or more than two and one third times as much.

TABLE IV.—FERTILISER USED PER ACRE

Country	Lbs. of Fertiliser Used per Acre
Holland	647
Belgium	513
Germany	200
United States	6.5
Canada	4.75

In the *Globe* (Toronto), recently, were quoted some figures given by Mr. Lynch, Director of the Department of Natural Resources, Ottawa, in which the amount of fertiliser used, per acre, by various countries, was given as per Table IV.

Although definite information is not available, it is reasonable to assume that some proportion of the large amount of fertiliser used in Holland is employed in the growing

of that country's wheat crop. On comparing, therefore, the above Table with the preceding one it will be seen that the use of fertiliser has a significant effect on the crop yield.

CONCLUSION

An attempt has been made to present, in very brief outline, the present general situation regarding nitrogen fixation; it has not been possible within the scope of this article to go into any great detail regarding any one portion of the subject. The whole matter is, however, assuming greater importance every year all over the world and is bound to become of steadily increasing importance in this country.—*Electrical News.*

Setting Poles with Dynamite

By F. F. Johnson, Florida Power and Light Company

IMAGINE your amusement and curiosity if you happened along in time to see a line construction gang go through the silly act of standing a fifty foot pole on end on the surface of the ground and then see the men stand back with rope guys and wait as if they expected the mythical "Paul Bunion" to come along with his hundred pound hammer and drive the pole to its required depth. But how your curiosity would turn to awe when you felt a slight earth rumble and witnessed the above pole sliding gently into the ground to a depth of eight, ten or twenty feet.

This is an everyday occurrence in Florida. The method of setting power and telephone line poles with dynamite had been developed into an art.

The story goes that several years ago the predecessors of the Southern Bell Telephone Company were erecting a telephone line between Indian River City and Orlando, Florida, which route included extremely wet, mucky swamp land. During the course of construction, a laborer in one of the gangs professed that he had been a "powder monkey" by trade and he insisted that the foreman give him a chance to blow a couple of holes in the muck and soft ground and then see if they couldn't jam a pole into the hole before it caved. Sure enough, the soil flew straight up, leaving an irregular unstable hole into which a pole was inserted to the required depth. This method worked out fairly well except when the hole caved too soon or the pole when once down came popping out as though it had hit a powerful spring. It happened that the foreman in charge of this particular gang was rather a playful sort and after wondering for some time just how high in the air a pole would go if stood on end over the powder hole before a blast, he let his curiosity get the better of his judgment—so he tried this thing which had kept him awake nights. When the "joke shot" responded to the electrical current from the shooting battery, all present were dumbfounded that the pole did not go rocketing skyward, but instead, quivered once and then settled into the ground without the flying of dirt as from the previous blasts.

With this start a study of the use of explosives in pole erection has led up to its present state of efficiency in soil conditions comparable with those in Florida.

Following is a brief outline of the present day method developed by the Florida Power & Light Company after experience in building more than a thousand miles of wood pole transmission lines. It must be remembered however, that one cannot take this article into the field and get results immediately. Although the method is applicable to conditions ranging from nearly dry soil to wet, mucky swamp land, considerable practice is required to arrive at encouraging results, particularly if long, heavy poles are used.

For swamp land at the pole location, a 1½ inch pipe is worked into the ground by employing the use of a ½ inch rod for a plunger inside the pipe. With this agitation at the point of piercing, the pipe is easily pushed downward by the weight of two men applied on Stilson wrenches at opposite sides of the pipe. The pipe is forced to a depth representing the depth desired to set the pole, the plunger rod removed, and several sticks of dynamite dropped into the pipe and pushed to the bottom. Oftentimes when there seems to be danger of the pipe clogging with earth when driven, a blasting point is used. This is nothing more than an eight inch length of 1½ inch pipe flattened out wedge shape on one end and coupled to the drill pipe, thereby allowing the pipe to be driven with mauls. In this case after the dynamite had been inserted, the drill pipe may be unscrewed from the blasting point. It is evident with this scheme that a new point is required for each shot.

The drill pipe is lifted out while the charge is held in position by a stick or wooden rod and is ready for the pole which is set directly over the dynamite.

When the blast occurs, the pole quivers and hesitates a moment, then slides into a hollow cylinder formed in the muck or soil by the force of the expanding explosive gases. The weight of the pole at the instant of fire tends to prevent an upward thrust and what little ground disturbance takes place is seen around the pole. There is no sharp report, but rather a dull thud. As the pole slides into place, gases from the shot leak out between the soil and the circumference of the pole. This pressure would indicate that the confined gases tend to retain the pocket walls awaiting the pole.

No advice can be given as to quantity of dynamite to be used. This is something to be worked out by each individual foreman. With practise a man can make a close estimate of required powder for a certain depth under certain soil conditions. Variations in depths and soil conditions make dynamite requirements vary from three to twenty sticks. In one instance a 65 foot pole was set to a depth of 25 feet in a muck sand ojus rock formation with one shot of 17 sticks of 40 per cent. dynamite.

A great upheaval of soil about the pole indicates an overcharge. Likewise, when a pole neither punctures the earth's surface nor goes to required depth, an insufficient amount of dynamite has been used. To

correct a "jam" the drill pipe must be worked at an angle to a point under the butt of the half set pole and a fresh charge inserted. When exploded this will, as a rule, send the pole to the required depth.—*O. B. Bulletin.*

Television

THE publicity given to transmission of moving pictures by radio brings up the question as to what extent development has been made in this direction. *Television* of November, gives the opening chapter of a book by Raymond Francis Yates, entitled A.B.C. of Television in which this question is answered and from which the following has been taken.

In 1884, Paul Nipkow, a more or less obscure German experimenter, applied for a patent on what he very aptly called an "electric telescope." Nipkow was no idle dreamer, for his patent specification, No. 30105, which is still available at the German patent office did something more than merely anticipate an approximation of contemporary television equipment; he prescribed it with precision. Minus a few modern conveniences and scientific refinements that were quite unknown in Nipkow's day, the present television receiver and transmitter is built, bolt for bolt and gadjet for gadjet, as this sanguine, hard-headed Jules Verne would have built it, at that time.

It is true that many of our greatest inventions are mere adjuncts to our senses; mechanisms that provide sensory projection or extension into realms beyond natural limitations. The telephone and radio, permit us to hear over appalling distances. Roentgen's X-ray and the microscope permit a marvellously intimate examination of matter. Television equips our eyes with a magic telescope, so to speak. Television is but another accessory for our most important sense, providing a practical realization of that age-old yearning to see over distances that defy our optical powers.

Although the fundamentals of seeing electrically were known to the writer, seeing his first practical demonstration held a fascination that almost bordered on awe. Here was the laughing face of a man whose actual physical being was located in an obscure room of a great factory several miles distant. Not a single movement eluded the keen, watchful eye of the mechanism before which he sat while the electrical equivalents of his likeness were flung into the great amphitheatre of space. His voice, perfectly synchronized with the movement of his lips, added a touch of realism—and there was the smoke from his cigarette!

The picture, measuring about 4 by 5 inches, was in tones of pinkish-red, a color which represents the spectrum of the gas, neon, contained in a special electrical lamp capable of jumping all the way from total darkness to full brilliancy as many as 100,000 times per second. The picture was divided up into 48 thin strips, each strip being separated by a very thick line of black.

Much like the movies of old, the reproduction at times stubbornly drifted from the field of vision only to be coaxed back into position by the operator. Judged by the high standards of present-day photography, this illusion was unmistakably crude but the fact that television had reached even such an immature state of perfection was in itself a significant happening. At least the man could be easily recognized and even such a slightly tangible thing as the smoke from his cigarette was sufficient to cause registration. Surely one could not help but be sanguine over the staggering possibilities of this new art.

Due to the highly imaginative and at times flagrantly speculative musings of the Sunday newspaper writers, television is at the moment, however, too enthusiastically appraised by the lay public. Already the public is talking of the imminence of home television perfected to a degree where it will be possible to enjoy a football game or a presidential inauguration from the vantage point of a luxurious living-room chair. While the patriarchs of engineering admit the possibilities, they seriously question the imminence, unless some unforseen development completely revolutionizes present practice. It must be conceded that appalling technical difficulties at present stand between football games and living-room walls. In the same breath it must be maintained that, even with the modest development that has taken place, television is practically ready for domestic application. Although the scope of the scenes scanned cannot include anything more pretentious or sizeable than intimate likenesses of broadcasting performers, the lure, the novelty and captivating fascination of the feat brings it within the possibilities of immediate commercial exploitation. Television is, by way of comparison, in its earphone stage of development.

The least that may be said is that television is ready to court the attention of that vast army of radio experimenters who so enthusiastically mastered the mystery of communication without wires. To the legion of amateur pioneers, television falls as a rightful heritage; it needs their patient hands and ingenious minds. Broadcasting received its original impetus from the inquisitive dabblers of 1920, who, through their activity in the fabrication of home-made receivers, brought the manufacturers rushing to the public with merchandise to satisfy a theretofore undreamed of demand.

Contrary to what appears to be the public notion, television is neither involved nor complicated. Some are inclined to measure the intricacy of a machine by the marvel of its product. This analysis does not always hold. It certainly does not hold in television. Living pictures are available to an ordinary radio receiver, the only accessory apparatus at present needed being a metal disc, an electric motor, and a neon lamp, which may now be purchased from a dozen different radio manufacturers. The only remaining requisite is the zeal and love for adventure in science-land.

Douglas B. Kennedy

On Tuesday, September 25th, 1928, in Toronto General Hospital, D. B. Kennedy, M.D., D.P.H., M.C., passed away.

Dr. Kennedy was born in Pembroke, Ont., and after attending public and high school there, entered Queen's University, from which he graduated in Medicine in 1902. He served for a year as house-man in the Water Street Hospital, Ottawa, and was then appointed Ship's Surgeon to the Elder-Dempster Line, operating on the West Coast of Africa. Returning to Canada in 1907, he engaged as physician in construction work for Messrs. Foley, Welsh and Stewart at Abitibi Crossing, during the construction of the Grand Trunk Pacific Railway. In 1913, he became a member of the staff of the Rotunda Hospital at Belfast, returning to Canada in the spring of 1914.

In November, 1914, he was gazetted Lieutenant Supernumerary, Army Medical Corps, later being attached to the Sixth Field Ambulance, C.A.M.C., and proceeding to France as Temporary Captain in September, 1915. He was mentioned in despatches several times for special gallantry under fire and was awarded the Military Cross, July 18th, 1917. In July, 1918, he was appointed Temporary Major and was demobilized in April, 1919.

Immediately after demobilization, Dr. Kennedy was appointed medical officer of the Nipigon Development, Hydro-Electric Power Commission of Ontario. During the lull in the construction work he was for a time on the staff of the Hamilton Sanitarium. He attended the University of Toronto for the term 1922-23, receiving the Diploma of Public Health. After serving for a year as bacteriologist in the Department of Health, Ontario, he returned to construction work as a member of the medical staff on construction of the Welland Canal. Early in 1926 he re-engaged with the Hydro Electric Power Commission of Ontario as medical officer, first on the construction of further plant at Nipigon and later in special work in Toronto.

Camp life as a boy on the upper Ottawa; on the senior hockey team on tour for Queen's; house-man in an Ottawa hospital; giving medical attention to an African explorer on a West Coast boat; operating on an Indian in the Northern Ontario bush with most primitive equipment; operating on a Canadian soldier in a captured German hospital with French assistants; acting as doctor and nurse during an influenza epidemic in a remote construction camp; the quiet fisherman on a trout stream; a laboratory man intent on careful investigation; such are glimpses of his varied and useful career, which his friends cherish, but above all the quiet, sincere and true man.

In the passing of Dr. Kennedy, the profession lost a brilliant diagnostician and an able industrial physician; the construction men, a kind and efficient friend who understood them whether native or foreign; and the growing youth, a sympathetic listener. "His life was an inspiration and his memory is a benediction."

WILLS MACLACHLAN

HYDRO NEWS ITEMS

Central Ontario System

The Peterboro Council has decided to present a by-law to the people for the purchase of the gas plant in the municipality at present operated by the Hydro-Electric Power Commission.

* * * *

An extension of the Peterboro Rural District to the village of Keene is now under consideration. This will mean an additional ten miles of line through one of the best farming districts in the country.

* * * *

The new 44,000 volt station erected by the Municipality of Whitby was put in operation for the first time on October 24th, 1928. This is a 750 kv-a. station of the latest design and is equipped with Reyrolle switch gear. Provision has been made for the installation of a second 750 kv-a. transformer which will probably be installed during the coming year.

* * * *

With reference to the last item of Central Ontario System news in last issue of the BULLETIN, we have received the following acid comment:

Your joke we think is quite a Frost,
In-Clement as the weather,
Dark and Drewry is your wit,
Light as a Nattress feather.
(Surtees thinks Mulholland is not a very good Iler.—*Ed.*)

Niagara System

Work is progressing on the new 26 kv. line to Merlin.

* * * *

Construction of the new sub-station at Leamington is making good progress.

* * * *

Sarnia Hydro-Electric System has completed the installation of new 4,000-volt bus and switching equipment in sub-station No. 1.

* * * *

It is planned to extend the Merritton sub-station to take care of additions to the industrial load which is growing rapidly.

* * * *

The first 3,000 kv-a. transformer of the Ford City sub-station is now in service. This takes care of the increased load at this point and relieves the present Walkerville sub.

* * * *

Preparations are being made to supply 100 horsepower to a natural gas company at Glenwood. This power will be used for purifying natural gas supplied to Hamilton, Brantford and other places in that district.

* * * *

Construction of a new distribution station to supply the town of La Salle and part of Sandwich Rural Power District has been started. The capacity of the station will be 600 horse-

power, and is expected to be ready for use by December 15.

* * * *

Work was commenced on the erection of a step-down station in Scarboro Township. This station is to be of the semi-outdoor type, the control equipment to be housed in a brick and concrete building with the main transformers outside. It will have an initial capacity of 3,000 kv-a. and will serve Scarboro Township, Scarboro Rural Power District and the Police Village of Agincourt. It is expected that the station will go into operation before the end of December.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Smiths Falls-Kingston, 110,000 Volt, 60 Cycle Transmission Line

SIXTY cycle power from the Gatineau River as arranged under purchase agreement of December 28th, 1927, was delivered through interconnecting lines to Kingston and the Central Ontario System on November 28th, 1928.

Power is carried from the Farmers Development on the Gatineau and the Bryson Development on the Ottawa River by the Gatineau Power Company to their Val Tetrault station which is located within the city of Hull. From this point, it is carried along the shore of the Ottawa River over double circuit steel tower construction to a convenient crossing at Remic Rapids which was the point for the supply as provided in the contract.

From this point, it is carried by the Hydro-Electric Power Commission of Ontario over double circuit towers, a distance of approximately two miles to a junction point near the south-west corner of the municipality of Ottawa. These circuits will supply the Ottawa district at 110,000 volts, and will be extended southerly and westerly as required. The first line goes to Smiths Falls. This line carries 477,000 cir. mils A.C.S.R. and is more or less standard, twin pole construction with ground wire and telephone circuit.

At Smiths Falls, the energy is stepped down to 44,000 volts which is the voltage most generally used in both the Central Ontario and St. Lawrence Systems. This station was described in the HYDRO BULLETIN, November, 1928. From this station, power is carried southerly over a wood pole line to connect with the existing St. Lawrence system at Brockville and a trunk line continues as a single circuit steel tower line in a south-westerly direction to Kingston

CONTENTS

Vol. XV **No. 12**

December, 1928

	Page
Smiths Falls - Kingston 110 kv., 60 cycle Transmission Line	397
New 5,000 kv-a. Synchronous Condenser for Oshawa Condenser Station	404
Application of Hydro-Electric Power to Farm Work	406
Power	413
The Swan Centenary	421
Presentation of Resuscitation Medals	425
What Caused the Accident?	426
Hydro News Items	428
Index to Vol. XV	430

where it connects with the Central Ontario System. This line will operate at 44,000 volts until the station at Smiths Falls is loaded at which time additional construction will be extended to Brockville or to Kingston or some other point on the Central Ontario System.

This Smiths Falls-Kingston line has several new and interesting features. The illustrations accompanying this article show many of these details. Most steel tower lines which operate at 110 kv. are constructed so as to carry two circuits. However, there is considerable advantage in having independent circuits arranged so that they are remote from one another. Less interruptions are likely to occur.

It is customary to design structures of this sort so as to resist with a reasonable factor of safety, a 60-mile wind across the line, *i.e.*, 8 lbs. per sq. ft. on the projected area of the conductors when covered with half inch radial thickness of ice. This line was designed so as to conform to that standard.

The line was constructed in a very short time. A great many men were available for construction work on this line during the Fall of 1928 as the 200-mile, 220-kv. Gatineau line was being completed during September. Several thousand dollars were saved in organization costs by

Fig. 1—A general view of the line. A rock footing in limestone is shown in the foreground.

Fig. 2—Details of rock footing near Battersea. The extra holes shown in the stub angles are provided so that legs can be telescoped so as to fit the uneven rock foundation without having to do any blasting.

having these gangs all ready to move in. The line is 49- 5/8 miles long. There were 232 standard suspension towers, 20 semi-anchor and 16 transposition towers, these latter are shown in Fig. 4. The conductors change places—one-third of a roll without any dead ending and the towers are therefore required two at a time. The average span is 984 feet.

Work was commenced August 3rd, 1928. It was necessary to assemble and deliver to the various sites, over two million pounds of material, of which 1 1/3 million lbs. was for towers. Some 75,000 pieces of steel and over 180,000 bolts were put in place. Work was completed and line was tested out on November 14th, 1928.

This single circuit line was laid out largely in comparatively rough country with quite long spans in an attempt to cut this single circuit cost to a minimum. The standard tower is probably the most economical structure of this type in use to-day. Flexible types may be cheaper but they do not have as great a resistance to loads in the direction of the line. It weighs 3,900 lbs. to which should be added 575 lbs. for earth footing, or 775 lbs. for rock footing. During factory tests it was evident that this structure could support without failure, when properly anchored, a horizontal load at a point approximately 60 ft. above the ground of 14,500 lbs., applied parallel to the line at the cross-arm. There are few tower designs which will show as great mechanical resistance as this one and at the same time provide proper space through the tower for the centre conductor, provide overhang for the outside conductor to clear the shaft,

and provide suitable connections for these and the ground and telephone wires.

Excepting for the 220 kv. Gatineau-Toronto line which was recently constructed, this line has the longest standard span which is operated by the Commission. The standard span for level country is 1,000 feet.

This tower, in addition to carrying the three conductors and a ground wire, is so arranged that a telephone circuit is attached to the tower. This was done so as to reduce the cost of the combination to a minimum. Telephone wires on independent poles would be more expensive. These

Fig. 3—A semi-anchor tower with suspension equipment in rocky country.

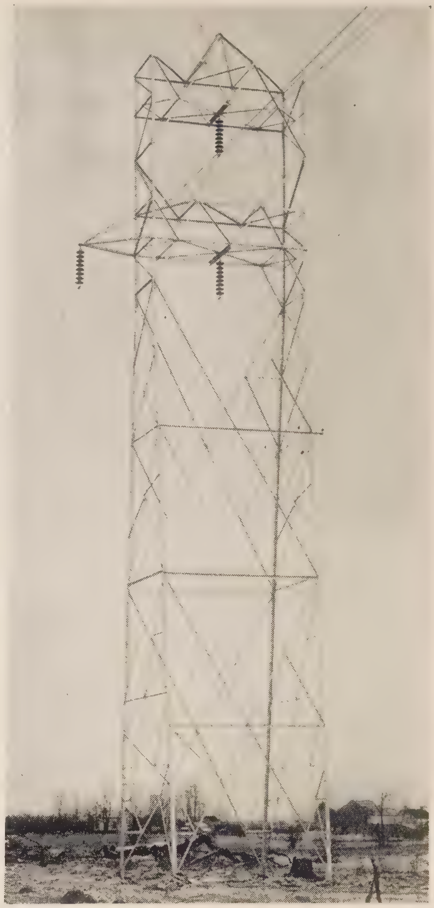


Fig. 4—A typical transposition tower. The brackets for the support of the telephone conductors can be seen.

telephone wires were located 30 inches apart. In a few cases such as at wire crossings extra supports are provided between towers by putting in independent poles. For all other spans porcelain spacers have been inserted at intervals between the telephone conductors so that they could swing without getting together.

The telephone conductors are cables, each composed of six strands

Fig. 5—The type of country through which these 1,000 ft. spans have been constructed. This photograph was taken near Battersea on the east side of the Rideau Canal.

of steel stranded about one core strand of aluminum, the outside diameter being approximately 3/16 in. The telephone conductors are transposed at each tower. There are eight transpositions in the power conductors.

Owing to the nature of the territory over which this line runs, two types of footings were used. One is called a grillage type, in which a network of beams and angles are placed approximately 7 feet below ground at each corner of the tower, the legs being carried to this buried grillage. For the rock conditions, the tower is secured directly to the rock by means of anchor bolts which are grouted in and split and wedged at the lower end. Where rock is encountered, the difference in elevation in the rock on each of the four legs, which are 16 ft. apart, is a considerable problem. This is taken care of by telescoping the leg members, *i.e.*, numerous holes are drilled in the leg so that it can be fitted to the various elevations for the horizontal channel irons which are bolted to the rock.

A standard type of suspension insulator was used on this line, eight at a time in the normal suspension position and ten insulators having extra mechanical strength, were used for dead-ends. 6,000 standard units and 1,200 of the special insulators were used on the line.

The three conductors for the steel tower line were 477,000 cir. mils A.C.S.R. as in the case of the line between Ottawa and Smiths Falls. They are so strung as to have a tension of 8,000 lbs. when loaded as above. The conductor has a diameter of .858 in., weighs .64 lbs. per foot and has a tensile strength of 18,750 lbs. It consists of seven strands of steel as a core and 26

Fig 6—Temporary 44,000 volt connection from steel tower line to Kingston substation.

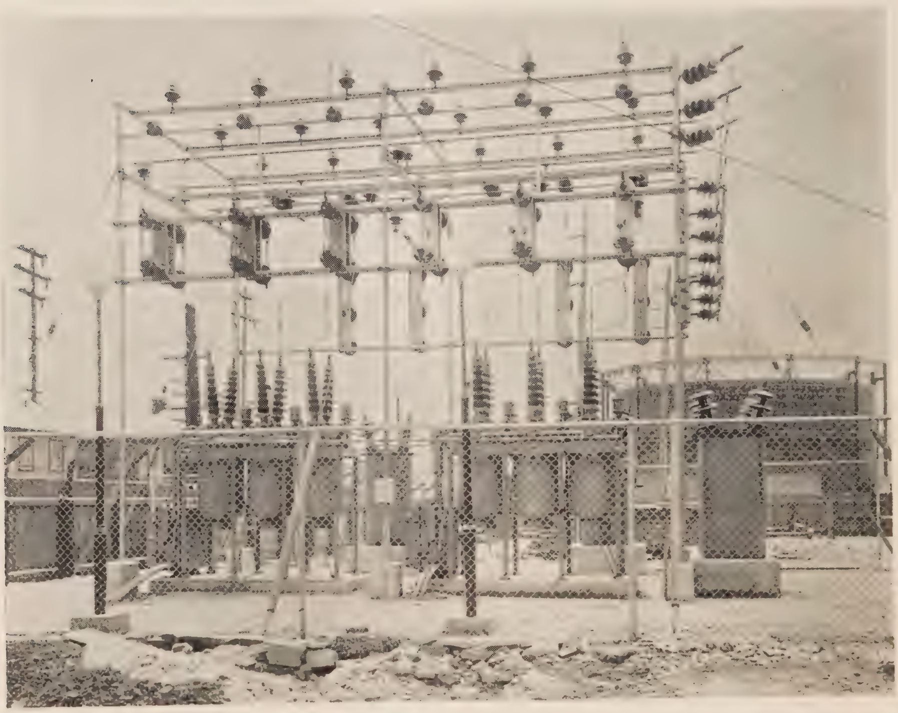


Fig. 7—Side view of 44 kv. outside switching structure at Kingston station.

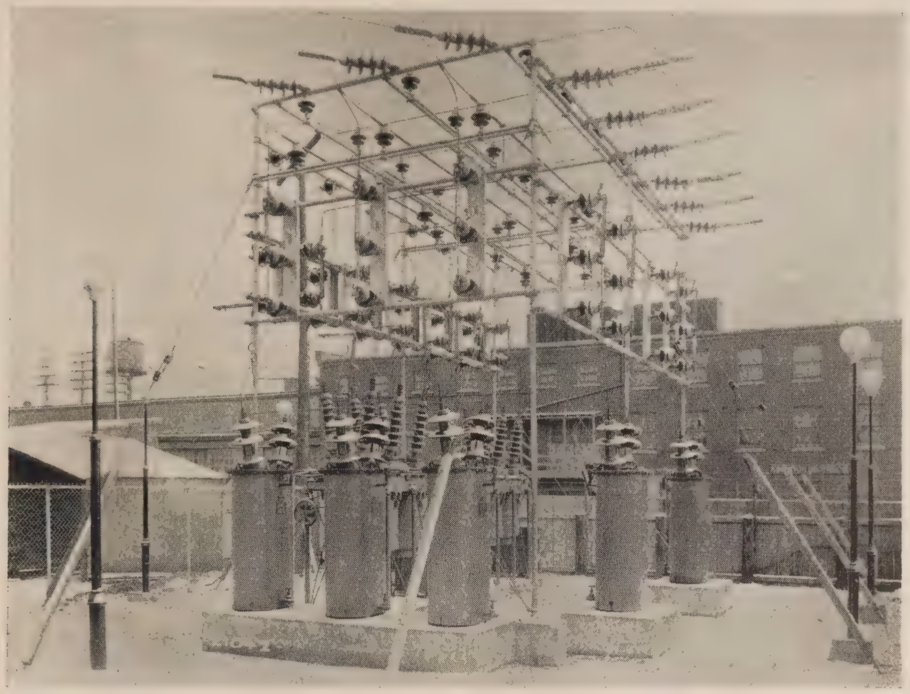


Fig. 8—End view of 44 kv. switching structure, Kingston station.

strands of aluminum in 2 layers around the core.

The single ground wire is 5/16 in. diameter, high tensile, seven strand steel, weighing 1,110 lbs. per mile. It will have a maximum load of 4,700 lbs. for the above loading assumptions.

A short piece of wood pole construction to operate at 44,000 volts is shown in Fig. 6. This type of structure connects the steel tower line, which is seen in the background of the photograph, with the Kingston substation. These structures are generally on roads and on the streets of the City of Kingston.

Two photographs of the Kingston substation which was described in the BULLETIN, November, 1928, accompany this description of the connecting lines.

New 5,000 kv-a. Synchronous Condenser for Oshawa Condenser Station.

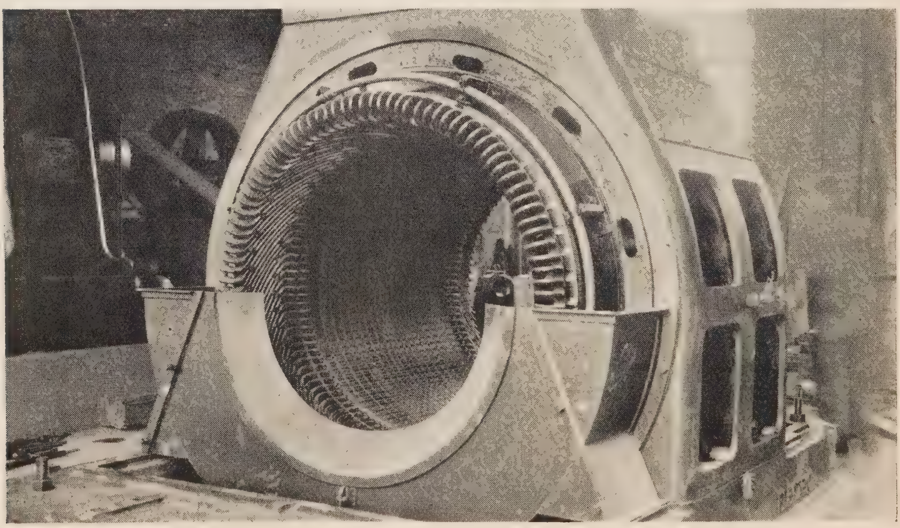
WITHIN the past year, industrial expansion in the City of Oshawa has resulted in heavy increases in load supplied by the Commission to this area. This has necessitated not only increasing the capacity of the existing distributing station but also has made necessary the erection of a second station in the northern section of the City.

Studies indicated that, with the increased load, a second transmission line from Trenton to Oshawa would be required, and that in addition an increase must be made in the synchronous condenser capacity at Oshawa.

Accordingly a 5,000 kv-a., 1,200 rev. per min. synchronous condenser has been purchased by the Commission and is now being installed alongside the existing 1,200 kv-a. unit in Oshawa Condenser Station.

The building for the condenser station, which adjoins No. 1 Distributing Station on the north, was originally built by the Seymour Power Company and contains two massive concrete engine foundations. The existing 1,200 kv-a. synchronous condenser is mounted on one of these and the new 5,000 kv-a. unit is being erected on the other. Certain alterations were necessary in the case of the latter foundation to provide an air tunnel for the ingress of cooling air to the new machine.

The machine itself is a horizontal shaft, 1,200 rev. per min., two bearing unit with direct connected exciter overhung outside one main bearing. As there is no outboard bearing on the exciter only two bearings will

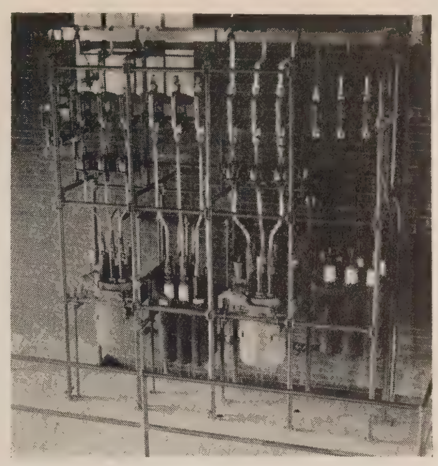


5,000 kv-a. Synchronous Condenser partially assembled.

require lining up. The cooling air enters a pit underneath the machine and, under the impulse of fans attached to the rotor, is drawn through the machine and expelled through a chimney or vent at the top. In the incoming air tunnel provision is made for the installation of air cleaners and damper doors are so arranged as to allow of the air being drawn either from outside or inside the building. In addition, automatic spring operated doors with latches connected to the relay system are so arranged as to instantly cut off the supply of air to the machine in case of trouble therein. The purpose of this is to prevent spread of fire in the condenser due to fanning action of the cooling air.

The new machine, together with the existing 1,200 kv-a. unit, will be connected to a condenser bus which will be fed through 1,200 ampere disconnects from either the main or emergency 4,160 volt buses in Oshawa Distributing Station No. 1. This condenser bus, together with the switching equipment for both units, is mounted on a steel and concrete gallery over the condenser starting panels.

Conduits running from the switching equipment to the units are carried beneath the floor which had to be specially supported underneath the switchboard to carry the weight of gallery and switching equipment.



Switching Equipment for Synchronous Condenser.

The switchboard panels carry the operating handles for the starting and running breakers, overload and differential relays, current and voltage indication for both a.c. and d.c supplies to both machines, and a totalizing reactive kv-a. meter which measures the reactive kv-a. being supplied by the two machines.

An automatic voltage regulator is also mounted which automatically adjusts the field current of the larger machine in such a way as to produce either a larger or smaller reactive kv-a. output as required to maintain a constant voltage on the Oshawa Distributing Station No. 1 bus.

It is expected that the machine will be ready for service before the first of January, 1929.

Application of Hydro-Electric Power to Farm Work

Article No. 18

Operation of Feed Choppers

(A revision of Article No. 10, now out of print, with notes on tests made while manufacturers were making demonstrations of this use of hydro-electric power on a farm.)

AS lines are being extended into farming districts, we are frequently asked for information as to the amount of power, the size of the motor needed and the amount of work, especially chopping, to be expected. This article is submitted with a view to giving assistance along these lines. The few facts and suggestions assembled herein are derived from the observation of results obtained in farm installations where Hydro is used.

Feed grinding is an important factor on the majority of our farms, as a great deal of the feed used is chop. The major part of grinding so far has been that of small grains only, but many farmers are now appreciating the desirability of having a chopper which, besides handling grain will also chop alfalfa and other materials. The oat-roll formerly used quite extensively is now found only on a few farms. Chop is used as feed for cattle and horses in a medium or coarse form and in a fine form for pigs and chickens.

It will be noted then that all choppers are being required to work through a range of fineness of chop, from small grains and material to quite a coarse product, such as chopping alfalfa, hay or straw.

Type of Choppers.

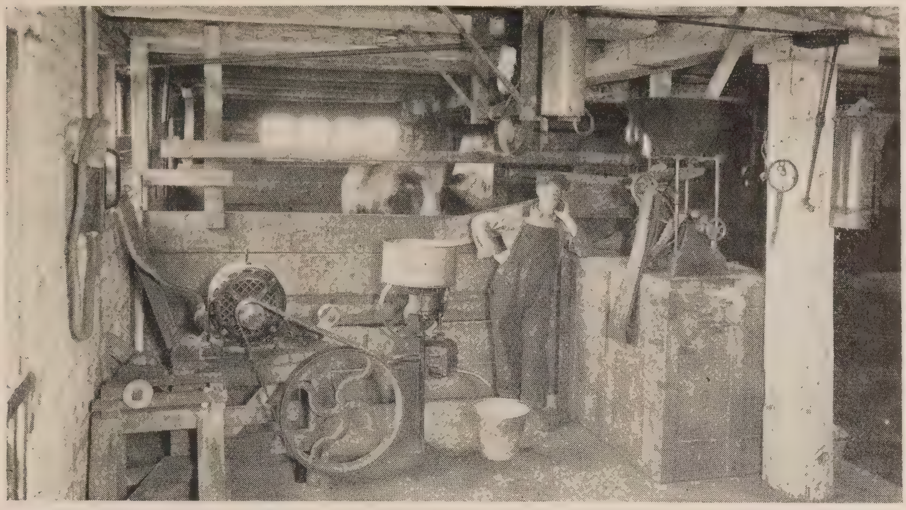
There are two general types of choppers found in use.

(*a*) The Burr with a stationary head and rotating plate. Of this type there are two distinct kinds, (1) the floating head and, (2) the rigid head.

(*b*) The Hammer Type Chopper, with a set of rotating hammers attached to a cylinder shaft, the whole of which rotates inside a replaceable semi-circular screen.

When the type (a-1) chopper—the floating head—is running idle, the plates are brought together by an eccentric lever and depend on the grain or material to hold them apart during the chopping process. Should there be a failure of flow of grain, the the plates will come together. Provision is made for solid bodies of a limited size such as nails, stones, nuts, etc., to pass through the plates. Four springs outside of the case provide for a release of the opening of the head to pass such particles.

The Rigid Head Burr (a-2) differs from the Floating Head Type in that the plates are held apart, adjustment pressure being exerted against a large spring located in the centre of the stationary plate. Should stones, nails, nuts or other foreign particles



A 3 h.p. motor in a barn, used to drive a milking machine, cream separator and chopper.

enter, the spring is compressed and permits their passage without wrecking the machine.

We find three kinds of the Hammer Type Mill in use:

1. Having fixed hard steel hammers rigidly attached to a shaft running with small clearance inside a semi-circular steel plate, which has perforations. The use of this plate controls the quality of the chop, as the material is pounded around this cylinder until the required fineness is secured, when it passes through the openings.

2. Same as No. 1, except that the ends of the hammers are split and spread, apparently with a view to increasing the area of contact with the material being pulverized.

3. This type has fixed discs with bolts through them on which are hung loose hammers. These hammers have stepped faces and by centrifugal force exert a pounding action on the material being put through.

All three of these Hammer Type Choppers have replaceable screens and the proper size for the fineness of chop desired is used.

Power Requirement

Burr Choppers use plates with radially cut surfaces or corrugations and in general have a capacity of about 100 lbs. of fine chop per horsepower per hour and 150lbs. or upwards of coarse chop per horsepower per hour.

The Hammer Type Chopper, the manufacturers claim, has a capacity of 80 to 100 lbs. per horsepower for fine chop. From reports, and from what we have noted, it would seem that the Burr Type Chopper has an average consumption on the farms of .6 to .8 kw-hr. per hundredweight, whereas the Hammer Type Chopper seems to have a consumption of 1 to 1¼ kw-hr. per hundredweight.

Speed

From tests made it seems important to make sure the chopper is driven at the right speed, although a good deal depends on the condition of the machine. In general it would seem the 6½ in. Burr Type Chopper should be run at a speed not exceeding 2,500 rev. per min. and an 8 in. Burr Chopper at 2,000 rev. per min. when belted direct to a 3 h.p. motor. The speed of these choppers could be increased to about 3,000 rev. per min. for the 6½ in. and 2,500 for the 8 in. when driven by a 5 h.p. motor, but not above this speed.

The small Hammer Type Mills we believe should be run at a speed of 2,000 rev. per min. when driven by a 3 h.p. motor and not to exceed 2,500 when a 5 h.p. motor is used.

Capacity

Weather conditions affect chopping capacities very greatly. From observation it would seem that in dry, crisp weather the output is considerably greater than when the weather is moist or humid. The quality of the grain seriously affects he capacity; when the grain is full and hard the output is high, when the grain has little starch and is mostly hull the capacity will naturally be light, as the grain will be tough, and the bulk greater per cwt.; grain cured in wet weather and harvested under bad conditions is always tough and hard to chop.

Other Work for Choppers

The chopping of alfalfa, hay and straw is so far the practise on only a few farms in the area of Ontario served by Hydro, although on the farms where this material forms a part of the feed the saving in concentrates reported would seem to be very great and so beneficial as a conditioner as to warrant a greater use of feed of this kind in this form.

Some of the farmers of the Province have been threshing their alfalfa in order to sell the seed. This leaves a residue in the form of a very dry material. This material has lost very little of its feed value, and if chopped even in a coarse form would reduce it to a very palatable article and, therefore, be very acceptable as good feed for cattle or horses. Should they wish to use any of this material for pig or chicken feed that part of it should be chopped fine. Alfalfa in this form is appreciated as a very valuable item to include in the diet of all animals and fowl.

The Hammer Type Mill, using the proper plate, can be used for chopping other materials, such as bones for chicken feed, making cracked wheat, or cracking other small grains if the hammers and plates are sharp. There will be a small percentage of fine material come through when cracking the coarser grains. Some few farmers have tried chopping grain with the straw in order to avoid thrashing. This is probably unwise, as the bulk of material must be reduced to a fine form in order to be sure that the grain is chopped. It would be better to chop the straw coarse and to chop the grain separately. This, of course, involves threshing.

General

No matter how much information should be assembled or tests made, the results would have so many

variable conditions and factors that it would be difficult to reduce them all to a clear basis by which comparisons could be made and, therefore, the results we have noted and the suggestions made are only comparative, as what the farmers of one district consider is fine, the farmers of another district may declare as not satisfactory. Likewise the quality of the material in one district may be vastly different to that in another.

Local conditions affect capacity and fineness of chop, areas adjacent to large open bodies of water have more moist days, whereas the sections of high land located away from such bodies of water, have very crisp, bright weather conditions, which, as noted above, assist very materially in quality and quantity of output.

Farm Chopping Installations—Burr Type

The samples of "Farm Chopping Installations" submitted herein give details only of machines of the Floating Head type. The Rigid Head type of machine, with ball bearings throughout, would probably have a somewhat higher capacity, but the capacity is not the feature of superiority of this type over the other. Its particular advantage lies in the ability to maintain the quality of chop at a definite setting, with longer life of plates, and its reliability of operation, even to the extent of being able to be absent from it for short periods of time while the chopper is running. Reports reach us of plates of the Rigid Head type lasting three or four times as long as those of the Floating Head type.

Sample Farm Chopping Installation—Burr Floating Head Type, with 3 Horsepower Motor Drive.

Mr. S. A. Davis farm—
Woodbridge, R.P.D.

Class 3 Service—Single-phase.

Total consumption and net cost for 14 months ending January 31, 1927:

Rate

Service Charge—$3.85 per month.

Consumption Charge—5c. per kw-hr. for first 42 kw-hr. in each month. 2c. per kw-hr. for the balance taken.

Discount—10 per cent on the whole bill for prompt payment.

Set-Up

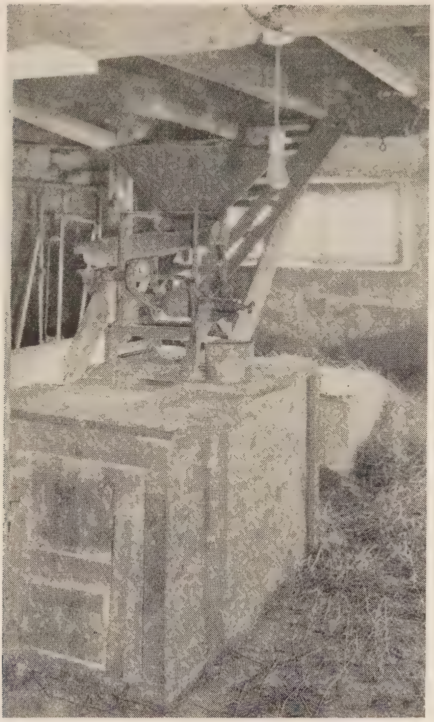
The motor is belted direct to the chopper. The chopper speed is the speed of the motor—1,420 rev. per min. The chopper is an old 8 in. "Vessott" or "Joliette" in good condition.

Output

The output was given to us for a four month period—Dec. 1 to March 31. It is known to be very low

Consumption and Net Cost

	Kw-hr.	Cost
1 month ending Dec. 31, 1925	23	$ 4.50
3 months " Mar. 31, 1926	110	14.40
3 " " June 30, 1926	52	12.74
4 " " Oct. 31, 1926	134	19.89
3 " " Jan. 31, 1927	151	16.52
	470	$68.05



A 6½-inch plate chopper, driven by a 3-horsepower motor mounted on the ceiling. The supply to the chopper is from a bin above, through the spout shown on the left of the hopper, the chop being delivered to the box on which the chopper is mounted. The hay on the right had just been put down. The tank back of the chop bin is an expansion tank connected to a watering trough on the outside to prevent breakage in case of ice forming in the trough.

during the summer months and is estimated for the whole year as 260 bags or about thirteen tons.

From experience and tests on other farms we find that the power required for this work would be 144 kw-hr. The capacity, as estimated by Mr. Davis, is 300 lbs. fine chop per hour, or 600 lbs. coarse chop per hour.

In addition to chopping, the motor is used for pulping roots, running grain-cleaning machine and a cutting-box.

Summary

This plant is well set up and economical to operate, as only the machinery in use is running when needed, and apparently from the records above all the uses are carefully watched.

The cost of chopping on farms should be considered on the consumption charge only, and if ordinary uses extend the charges to the follow-up rate this rate should be used for computing cost, therefore on this place on this basis (all at the first rate) the cost per cwt. is 2.49 cts.

Sample Farm Chopping Installations—Burr Floating Head Type with 5 Horsepower Motor Drive

Mr. Thos. A. Keffer—
Woodbridge, R.P.D

Class 5 Service—Three-phase.
Motor in use about nine years.

Rate

Service Charge—$4.90 per month.

Consumption Charge—5c. per kw-hr. for first 70. kw-hr. in each month. 2c. per kw-hr. for the balance.

Discount—10 per cent. on the whole bill for prompt payment.

Total consumption and net cost for year ending October 31, 1926:

Recorded on Domestic Service Meter........	933 kw.-hr.
Recorded on Barn and Outbuilding lighting meter...............	258 "

Recorded on 3-phase power meter (5 h.p. motor only)........1776 kw.-hr.

Total..........2967 "

Cost.................... $129.01

The work done by 5 h.p. motor for the year was (as given to us by Mr. Keffer):

Chopping of 2,000 bushels of grain.

Rolling of 800 bushels of grain.

Pulping of 1,200 bushels of roots.

Milking 15 to 18 cows twice per day all the year.

Running a cutting box for cutting hay or straw—about 60 hours.

Operating a fanning mill for cleaning grain for seed or sale 5 to 6 days.

Operating a meat chopper 1 day.

Operating an elevator for handling the grain from the thresher to the granary while threshing, about two days.

The Set-Up

The assembly of machinery and method of drive on this farm is not good. The drive to chopper and oat-roll should be direct and the line shafting used only for that machinery with the lower power demand. The motor has a full load speed of 480 rev. per min. It would have been better to have a 1,500 rev. per min. motor, but since the 480 rev. per min. one is now in use, a better set-up could be made by using a proper sized pulley on the motor for the correct speed of the chopper. Change the pulley on the oat-roll to one that would give a proper speed when driving from the same pulley installed for chopper drive and drive a shorter line shafting by using a slip or collar clutch of some kind on the end of the motor, having the pulley arranged to suit the clutch.

Output and Capacity

With a proper set-up driving the chopper at 2,000 rev. per min. instead of 2,460 as at present, the capacity would be greater. In fine chop it should be 500 lbs. per hour and 1,000 lbs. per hour of chop suitable for cattle and horses. At present the rolled oats is used for horses and a small amount for some cows. The capacity of the roll is about 1,000 lbs. per hour.

Power Uses

Of the 1,776 kw-hr. used by the 5 h.p. motor about 700 are chargeable to chopping, 100 to rolling grain, about 25 pulping roots, and the balance 976 to milking, pumping water, cleaning grain, cutting hay and straw and cutting and chopping meat.

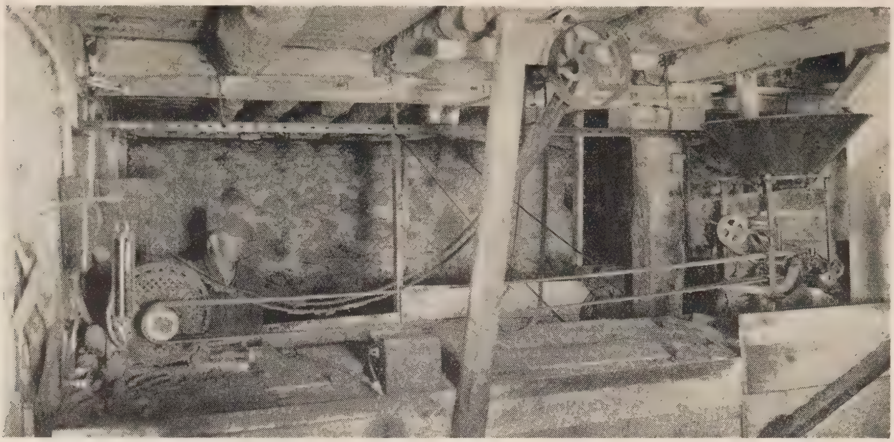
The cost of chopping on this farm, all at the follow-up consumption rate as current at that rate would be dropped from the total if it were discontinued (40 tons 800cwt.), is 1.58 cts. per cwt.

Hammer Type

Reliable information on hammer type choppers is not available, only a few are reported as in use on farms served by Hydro.

Tests on Farm in Listowel, R.P.D.

Tests made in the Listowel Rural Power District while a demonstration was being made of this application of Hydro-Electric Power by motor and chopper manufacturers confirmed the



A 5 h.p. motor belted to a chopper. This motor also drives a line shafting to which are belted a root pulper and a fanning mill.

opinion of the commission's engineers in the conclusions formerly arrived at and expressed in a general way under the heading "General" as follows:

1. That each size and make of chopper has an economical speed.

2. That there are so many variable conditions and qualities of chop that until these are reasonably stabilized tests can only be comparative.

3. That a very small chopper will do all the work required on the ordinary farm in less time than is necessary for "stable chores" daily during the season when chop is used.

4. That the speed mania of to-day applies to farm machinery as well as to other things, most choppers in use to-day on farms are operated at too high a speed.

5. That there is only a small amount of chop used on the farms that must have the husks chopped fine, *viz.* that for pigs.

6. It would appear from these tests that the economical speeds for choppers under observation are:

For 6in. —1,500 to 1,800 rev. per. min.
For 8in. —1,400 to 1,700 "
For 9¾in.—1,200 to 1,600 "

7. Apparently the form of the worm affects the amount of work done and power taken greatly, slippage or grip on the grain being the factor.

8. The form or type of plate also affects the quality of the chop and the rate of output greatly.

9. That in order to chop the hulls fine using a minimum of power they should be separated from the starch and made a second operation instead of trying to do it all in one.

To illustrate conclusions 1st and 2nd. When chopping about 400 lbs. per hour, very fine, the power taken was—

At 2,200 rev.per.min. — 4.3 h.p.
At 1,900 " — 3.8 "
At 1,580 " — 3.6 "

Expressing this in another way, we find that limiting the amount of power taken to 4 horsepower, the output was 460 lbs. per hour when operating at a speed of 1,710 rev. per min. and 316 lbs. per hour when the speed was 2,000.

Power

By M. Grattan O'Leary

(*The magnitude and utilization of the water powers of the Dominion of Canada are factors of great importance in its development. Mr. O'Leary gives us in limited space a discussion of this subject. As the* BULLETIN *has not attempted to verify any of the data given it must necessarily leave all questions as to the accuracy of the article with the author.*)

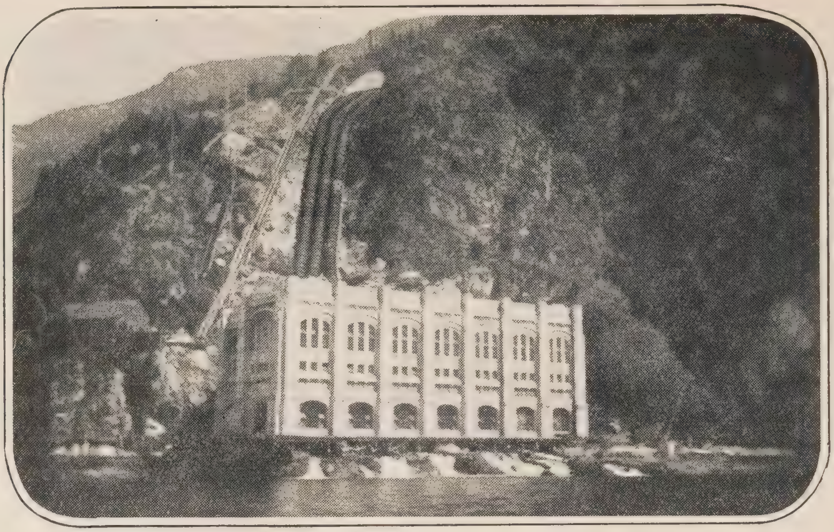
"POWER," wrote David Lloyd George in 1924, "is the key to the future."

"Power," declared Herbert Hoover in 1926, "is the mightiest magic of modern times. Just as coal and steel reared England's supremacy in the nineteenth century, so will that nation which can utilize the maximum of electrical power dominate the industrial future."

For Canada, such words are of mighty portent, says Mr. O'Leary in MacLean's Magazine. With countless rivers and waterfalls dotting a land 3,000 miles in width, and running from the United States border clear up to the Arctic circle, they open up a vista of achievement through the years that must stir the imagination. What power will bring for Canada in the future must be left to the revelation of time. But those who believe in the economic interpretation of history, and who have grasped the already demonstrated effect of electrical energy upon industry, cannot but believe that its influence will be decisive.

The great empires of the past reared their industrial and political might upon economic foundations. Spain's greatness was builded upon fabulous possession of gold; England's commercial and mercantile predominance had its origin in coal; the United States rose to richness through her vast and varied resources. And so all down through history. Underlying the rise and progress of peoples, shaping their destinies, and moulding their parts in the world's story, have been certain physical and geographical and natural advantages that can be traced and clearly defined.

So, we can now believe, it will be with power. Already world industrialists and statesmen concede that electrical energy, meaning cheaper production, holds the way to commercial supremacy. It is that recognition that sees the textile industries of New England flocking to where cheap power may be had. It is the same vital factor that is bringing treasures of capital to, and building cities overnight, in the Province of Quebec. The identical recognition that gives momentum to



Lake Buntzen generating station of the B. C. Electric Co.

the clamour, both in Canada and the United States, for the St. Lawrence development. Power, in a word, has come to be regarded, in Lloyd George's phrase, as the key to the future.

Let us see, if we can, what it may mean for Canadians. Twenty years ago, when Laurier, far ahead of his time, proclaimed the twentieth century as belonging to Canada, power development was all but unknown. To-day $900,000,000—$100 for every living soul in the land—are invested in hydro plants; the industry is more heavily buttressed than any other. In seventeen years that investment has grown more than 600 per cent.; $180,000,000 have gone into it during the past three years; more than $80,000,000 will go into it this present year. Already, indeed, this country has the second greatest per capita installation in the world—513 h.p. per 1,000 of population, next only to Norway. And we have but touched our capacity.

We have developed 4,883,266 horsepower, but our total and easily available horsepower is over 20,000,000. It is, in truth, far more than that, for this estimate, made on a precise calculation by the most eminent engineers, does not include great power sources of the north, of which little is known. Twenty years ago Nelson was but a name upon the map. Twenty years ago Churchill and Reindeer were but terms in exploration. Yet Nelson, with more power than Niagara, and the Churchill and Reindeer, with a million horsepower each, have as much power among them as is now developed in the whole of Canada. Nor are they all. There is the Thelon, navigable for a greater length than the famed Amazon, mightier than the St. Lawrence—who can guess its potentialities?

More than sixteen million undeveloped horsepower—what does it mean? What would its utilization hold for the development of Canada?

Let us use but one illustration. In the *Journal of Electricity*, a few years ago, there appeared an authoritative calculation of the definite effect of power development when applied to new employment, new jobs, additional wages, and population growth. The figures given, based on units of 1,000 horsepower, were as follows:

1. That a total of 385 new employees—new jobs— would result from each 1,000 horsepower developed.

2. That these 385 employees would draw in wages—new money put into circulation—the sum of $581,100 a year.

3. That on the basis of one active workman supporting an average of five souls, each 1,000 new horsepower developed and supporting 385 new workmen would represent a new population of 1,925 souls.

Sixteen million horsepower, approximately the total of undeveloped power in Canada, is 16,000 units of 1,000 horsepower each. Therefore, with all our available power developed and utilized, there would be employment for a new population of 6,160,000 wage-earners, supporting an additional population of 30,800,000 souls, and drawing in actual cash wages, the stupendous sum of $9,279,600,000 a year.

Let us try to imagine what this, or even a part of this, would mean to Canada's position in world trade! Let us try to visualize its relation to our problems of immigration and emigration! Or its effect upon our railway problem; upon our home markets and purchasing power; upon the growth of our towns and cities; upon the development of our harbours and ports!

The Last Great Empire

There are those who say that the time will never come when Canada will need this horsepower. They forget their history. They lack the imagination to cast their minds back two generations in our story. Let us pause here for a moment to consider it. Two generations ago: the West a vast wilderness of prairie and snow, roamed over but by the buffalo, the Indian and the lone pioneer; to-day: the home of nearly two million people, dotted with towns and cities, crossed by two great transcontinentals, the last great granary of the world.

Two generations ago: British Columbia, severed from the rest of Canada by the Rockies; puny in population and development, with one or two struggling towns; to-day: a mighty province, developing its heritage of forest and mine and sea, whose cities, looking out upon the Orient, send their rich cargoes across the Pacific, or through the Panama Canal to all the world.

Two generations ago: Northern Ontario a primeval wilderness, known only to a few trappers, a land of rock and marsh and waste; to-day: one of the world's great mining areas, yielding fabulous riches in copper and silver and gold. Two generations ago: Canada a land of primitive industry whose total trade was less than half a billion; to-day: a nation of giant industries whose trade exceeds two billions, and whose per capita exports are the second largest in the world.

In an outline of world history, two generations are but a pulse-beat; in the story of Canada they seem a long time. But, considering the

The Horseshoe Falls power plant on the Bow River, Alberta.

transformation that has come within living memory, the massive march of exploration and invention and science, the modern industrial revolution, the discoveries that have made this half of the northern continent the last great empire of man, what mind can measure this nation's progress in future years in the realm of, and because of, power? Explorers and scientists, penetrating the North, tell of unimaginable riches.

The Peace River flows through cliffs of coal, past springs of oil, which spreads over the surface of the river. In northern Quebec, in northern Ontario, on the Hudson Bay, in northern British Columbia, mighty mineral deposits and vast forests await adventurous man. When the day comes—as come it must—when these resources come to be tapped, who shall say what it will all mean to this land's industrial greatness? What then will be the place of the turbine and the dam?

More than Doubling Every Ten Years

To-day, already, the part that power is playing in Canada in cheapening production, in the expansion of industry, in the reduction of the cost of fuel, and in heightening the social and economic life of the people, is almost beyond computation. Fortunately, as if by Divine plan, our great developed power resources are located in areas far distant from coal. Quebec and Ontario, for example, are barren of coal, but they are rich in hydro power. The power developed by these two provinces supplies the equivalent of 20,000,000 tons of coal per annum; so that it requires but a simple calculation to discover that Central Canada, which now imports 15,000,000 tons of coal each year, would have to import 35,000,000 tons were it not for power. What that means in money kept in Canada,

and what it means, too, to a part of the Dominion not infrequently menaced by the spectre of a coal famine, must be plain to the meanest intelligence.

Development and installation of hydro power in Canada proceeds at a tremendous pace. Consider these figures:

1901	150,000 h.p.
1910	1,000,000 h.p.
1920	2,500,000 h.p.
1925	4,300,000 h.p.
1927	4,833,266 h.p.

During the first six months of 1928, according to official figures, development continued at an unabated pace. At the present date, indeed, it is estimated that the total installation in the Dominion is more than 5,100,000 horsepower, which is just double the installation at the end of the year 1920. Moreover, numerous undertakings are now in the initial stages of construction and others about to be commenced, the result of which will be to add at least 2,000,000 horsepower more to the country's developed total by the end of 1930.

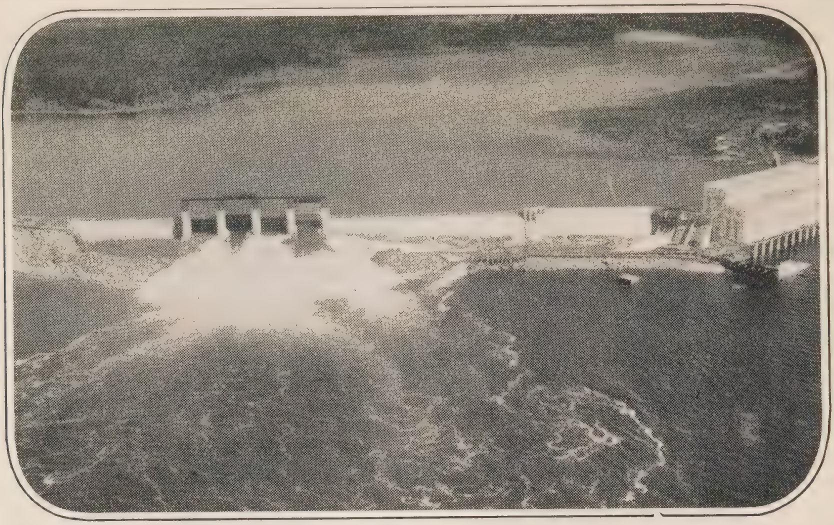
By the end of the present year, it is safe to say, more than $1,000,000,000 will be invested in Canada in power. And this capital, let it be borne in mind is mostly Canadian. We hear much in these days of the domination of an economic life by United States finance. That claim, whatever truth there may be in it, does not apply to the ownership of our power. The capital invested in it, by nations, is as follows:

	Per Cent.
Canadian	66.9
United States	15
British	6.3
Others	11.8

Hydro development, in truth, has been Canada's greatest achievement during the past ten years. Mighty transformations are being made throughout the land. In Quebec small-sized and prosperous towns stand to-day where, only a few years past, there was little but marshy land. A few miles from Ottawa the entire face of the countryside has been changed by a titanic dam across the Gatineau. This turbulent Laurentian torrent is now a placid river; water has been raised twenty feet; whole tracts of territory have been inundated. And out in Alberta, it is proposed to dam off glacial lakes, tunnel through a vast peak of the Rockies to bring water to the Bow River for power purposes. The whole layout of nature is being challenged and changed.

The Cheapest Power in the World

Apart altogether from industry, from the cheapened and enlarged production which is making Canada a factor in world trade, providing jobs and wages and purchasing power for Canadians, a home market for Canadian agriculture, traffic for Canadian railways, and shipping for Canadian ports, power has become a tremendous factor in the domestic life of the nation. Two generations ago half Canada lived by candlelight. The early pioneers and their descendants looked upon the country's great falls and rapids as a affliction, and while they used water



The Great Falls development on the Winnipeg River in Manitoba.

power for grist and saw mills, the idea of taking light and heat from water was not even a dream. To-day domestic consumption of power has reached the enormous total of 4,000,000 horsepower, developed by 308 generating stations; 1,252,699 publicly owned, 2,759,729 in private hands. The humblest Canadian farmer to-day, in the most remote part of Central Canada, enjoys lighting facilities beyond the dreams of palaces fifty years ago.

Financially, too, hydro, whether privately or publicly owned, has been a success. Except for the Prince Albert development at LaColle Falls, where the circumstances were exceptional, no record exists of a hydro plant in any part of the North American Continent having gone bankrupt. And rates almost steadily decline. From 1913 to 1920, largely because of war conditions, they advanced, but since 1920 there has been a reduction of thirty-one per cent. Canadians, in fact, secure power more cheaply than any other people in the world.

What this means to a province like Ontario may be realized by a quotation from the "Electrical World" one of the most authoritative of United States magazines in the electrical field. Estimating that the grand total of electrical consumption in the United States during the year was 47,999,000,000 kilowatt hours, for which was paid $1,389,000,000, "The Electrical World" said:

> "If we Americans had paid Ontario rates we should have saved ourselves in 1926 the sum of $600,000,000."

In 1926, as a matter of official fact, United States electric current for domestic use cost an average of 7.5 cents per kilowatt hour, as compared with 1.85 per kilowatt hour in Ontario. The Americans, in other words, paid just four times as much

as the people of the Province of Ontario.

Where Quebec Leads

It will help us to get a clearer view of Canada's enormous power resources if they are summarized by provinces. Quebec, to begin with, is the banner power province. The St. Lawrence falls from a great height through a series of rapids to near the sea level at Montreal, and fed by huge reservoirs of great lakes to ensure a steady flow, is a Niagara twice over. Then, too, are large power sites on most of the rivers flowing south into the St. Lawrence. And, finally, to the north and west of the Laurentians, great rivers flow to the North Atlantic and Hudson Bay with unexplored but mighty possibilities. The total possible development in Quebec is placed at 13,000,000 horsepower, but it is admittedly a conservative estimate. Thus far there has been installed 2,165,443 horsepower, of which 75 per cent. is used by the great industries that are everywhere springing up; and a number of other gigantic development projects are under way.

Power installation in the Province of Quebec during the past twelve months has proceeded upon an enormous scale. There were the Chelsea and Farmers developments of the Gatineau Power Company, the first of 102,000 horsepower and the second of 72,000 horsepower; the Paugan Falls development by the same company of 204,000 horsepower, and from which a transmission line is being constructed to connect with one being built by the Ontario Hydro to carry power to Toronto; the 165,000 volt transmisson line built by the Shawinigan Power Company from the Saguenay River to Quebec City; the 800,000 horsepower development of the Alcoa Power Company at Chute à Caron on the Saguenay; and various other lesser enterprises.

Next to Quebec, Ontario is Canada's greatest power reservoir. It has an estimated power of about 6,000,000 horsepower, of which 1,827,000 horsepower is developed, 900,000 of which comes from Niagara. The bulk of Ontario's developed power is publicly owned, the Ontario Hydro Electric Power Commission being the largest publicly owned utility of its kind in the world. This commission owns and operates eight separate systems in various parts of the province; has 22 generating stations with a total installation of 1,050,000 horsepower; and serves the entire populated part of the province. During the past year, the Ontario Hydro launched upon the construction of a 220,000 volt transmission line to bring to Toronto and the Niagara System the 260,000 horsepower which the commission contracted to take from the Gatineau Power Company. It also carried forward construction on its Alexander Landing development on the Nipigon River, which, when completed in 1929, will have an installation of 54,000 horsepower, and will serve Port Arthur, Fort William and the district of Thunder Bay.

Manitoba's power possibilities are enormous. Its minimum flow is placed at 3,309,000 horsepower; its

maximum flow at 5,344,000 horsepower. Up to the present, however, its total installation is less than 260,000 horsepower. The bulk of Manitoba's power is in the northland, where, of course, it must await industrial expansion before being brought into use. The Nelson, draining 450,000 square miles, has larger power possibilities than Niagara. Then there is the Churchill; the Saskatchewan, which enters Lake Winnipeg at Grand Rapids; the Dauphin; the Waterhen; and others. As the province opens up, and vast enterprises like Flin Flon get into operation, these resources will be called upon.

British Columbia, because of its vast and varied resources, and because it is blessed with rivers and waterfalls, is destined to become one of the great power areas of the Dominion. With a possible development of over 5,000,000 horsepower, its total installation to date is less than 500,000 horsepower. At the present time the British Columbia Electric Company, which has just been purchased at an enormous price by Montreal and British interests, is carrying on extensive preparatory work in connection with a project of 500,000 horsepower ultimate capacity; the West Kootenay Power and Light Company have just completed a new 60,000 horsepower development on the Kootenay River; and other projects under way include a 70,000 horsepower development on the Campbell River and a 60,000 horsepower installation on the Campbell River.

Alberta and Saskatchewan have a total available horsepower between them of over 2,000,000 horsepower, with but a tiny fraction of it thus far developed. The Maritimes, on the other hand, with a possible development of 500,000 horsepower among them, are making rapid strides in installation. In New Brunswick, during the past year, the Saint John River Company made rapid progress on the construction of its 80,000 horsepower development at Grand Falls on the St. John River; the New Brunswick Electric Power Commission extended its transmission lines to a number of municipalities; and two tidal power projects are under investigation on the Bay of Fundy.

Apart from possible tidal developments, the Grand Falls power site is the largest in the Maritimes. This particular development is unique in that the water from the dam above the falls reaches the power house through a tunnel in solid rock that passes directly under the town of Grand Falls. The power generated here will be used principally in newsprint mills to be erected in Northern New Brunswick.

In a brief article such as this, a complete and detailed survey of all Canada's power activities and potentialities is manifestly impossible. Enough has been said, I trust, to reveal to the reader some slight idea of the vast heritage which is Canada's, of the mighty possibilities which power holds for the future of this land among the nations of the world.

The Swan Centenary

WEDNESDAY (October, 31st.) was the centenary of the birth of a man whose inventive genius was responsible for the creation of a great industry. The story of the life of Sir Joseph Wilson Swan, who was born on October 31st, 1828, is an inspiration to every Englishman and a source of patriotic pride.

To his pertinacity and courage in the face of a thousand difficulties and countless disappointments we owe the incandescent electric lamp, that means of illumination that has revolutionized lighting throughout the world, that has made much of our present civilization possible.

The story goes back to 1845, when Joseph Swan joined his brother-in-law, John Mawson, a chemist of Newcastle-upon-Tyne.

Always of an inquiring turn of mind, the lad allowed no opportunity of acquiring knowledge to pass him by; and when W. E. Staite, the inventor of a regulating arc. lamp, came to Sunderland to lecture, young Swan was among the audience. He was intrigued with the small electric light Staite had produced by an electrically-heated wire of platino-iridium. The only means of generating electricity at that date was by means of the nitric acid battery, and Staite's efforts were accordingly restricted.

But the electric light, primitive and inefficient as it was, set the young chemist on a voyage of discovrey which culminated in success more than thirty years later.

John Mawson, the Newcastle chemist, was the possessor of a chemical apparatus department, a very unusual adjunct to an early Victorian chemist's shop. In this department young Swan spent every possible hour, encouraged largely by John Mawson, who saw in the boy something of a genius that the years were to mature.

Swan was struck with the idea that the carbon conductor must be as thin as possible if a successful incandescent electric light were to be produced, and his first experiments were directed to the attainment of this object, by means of carbonized paper and carbonized cardboard.

A couple of years later he obtained a number of different kinds of paper and cardboard and cut them into strips. He packed them in a mass of powdered charcoal in a fireclay crucible, and then baked the vessel and its contents to a high temperature in a pottery kiln. Some of his strips were spiral, and both the strips and spirals came out of the kiln perfectly carbonized and very thin. This boy of 19 had discovered a new way of carbonizing thin and flexible strips, and he believed that his battle was nearly won.

But there were many other problems to be solved before the effective incandescent lamp was evolved, and many a long year passed by before Swan made any further real progress. In 1860 Swan set about constructing a lamp, and one form he used was a glass bottle with a wide neck closed with an indiarubber stopper! He

passed the conducting wires through the stopper and placed the carbon strip between their ends. Another improvisation consisted of a glass bell-jar inverted over a sole plate. He exhausted the air, so far as he could, from these containers by an ordinary air-pump and by means of a battery of 50 collon's cells, he actually succeeded in rendering a carbon strip about ¼ in. broad incandescent.

The presence of a little air in the container, together with distortion of the carbon under the action of unequal heating, caused the contrivance to fail before it had given much service. But the principle was established, and it but awaited the advent of a sufficiently cheap supply of electricity to make the existence of an incandescent light a commercial possibility.

It was two years later—in 1862—that the first commercial electric lighting plant was installed in Dungeness lighthouse—a magneto electric machine, crude in type, and a Serrin arc lamp.

The next ten years saw immense activity in electrical engineering, and whilst Swan's main interests during this period were directed to photographic inventions, notable amongst which are his discovery of the bromide paper and the dry plate, he nevertheless kept a careful eye on discovery and invention in the electrical field.

The Next Step

Sprengel's mercury vacuum pump of 1865 marked a considerable step forward in the securing of a vacuum, and when, in 1875, Mr. Crookes, (afterwards Sir William Crookes) exhibited his radio meter, Swan was immensely interested in the description of Crooke's method for obtaining so near an approach to a perfect vacuum. By a fortunate chance reading of an advertisement, he discovered that a young bank clerk of Birkenhead, Charles H. Stearn, was assisting in the manufacture of the radiometers, and was thus thoroughly familiar with the method used to secure this high degree of evacuation.

Swan got in touch with Stearn, and the two commenced a series of experiments to test the truth of Swan's idea that strips of carbonized paper made incandescent would be indefinitely durable if only they could be contained in a perfect vacuum.

The carbonized strips and spirals were mounted in glass bulbs, and the bulbs then evacuated to the highest possible degree. The contact between the ends of the carbon strip and the conducting wire between which it was held presented great difficulty, but this difficulty was overcome by discarding the carbon film and substituting for it carbon wires. These were fitted in small platinum—note the metal—sockets and "stayed put."

In the course of the experiments the vacuum rapidly deteriorated because air and other gases were evolved from the carbon as soon as it began to incandesce. This difficulty was overcome by producing as nearly perfect a vacuum as possible by exhausting the lamp bulb when the carbon was cold and then passing a strong current through it, making it brilliantly incandescent, whilst the process of exhaustion

was continued at this high temperature.

This discovery solved the difficulty. The vacuum was not destroyed when the lamp was put into service, the carbon did not waste away, and the lamp was a success.

Think for a moment what it meant to Joseph Swan. Thirty-three years after his first efforts, he saw his dream brought to reality. He had followed a will-o'-the-wisp and found it, not a figment of the imagination, but rather an idea so sound in its conception, so important in its consequences that it opened up a new vista, a new era in lighting and all that lighting means in the way of progress, technically, industrially and socially.

Public Interest

On December 18th, 1878, Swan demonstrated an incandescent carbon lamp before the Newcastle-upon-Tyne Chemical Society, and again on January 17th, 1879, the lamp was shown to a technical gathering.

In February of that year the audience of 700 which attended a lecture he delivered to the Literary and Philosophical Society of Newcastle saw the new lamp in operation, and so great was the interest aroused that Gateshead insisted upon a similar lecture and exhibition. The Town Hall was taken for the occasion, and there on March 12th, 1879, some 500 gathered to see the new marvel.

Swan did not rest on his laurels. The manufacture of the lamp on a commercial basis was the next step, and a preliminary was the improvement of the carbon.

Swan discovered a new material in place of the paper thread or other porous body used as the carbon-forming substance. Treating cotton yarn of an open texture with sulphuric acid, he found that it became so agglutinated and compacted that it lost its fibrous condition. On drying it became hard like catgut and could be drawn down through dies to a wire of perfect roundness. This "parchmentized thread" was patented by Swan in 1880 and it marked an immense advance in incandescent lamp design. In the same year he patented the special process of evacuation, allowing two years to pass by whilst his invention was being perfected.

On November 10th, 1879, Thomas Edison obtained a British patent covering, in the broadest terms, the invention of an incandescent electric lamp, possessing as its cardinal feature a glass container from which the air had been exhausted. This patent was granted nearly a year after Swan's successful demonstration of his lamp at Newcastle, and it was not till February, 1880 that any Edison lamps were seen in England. The first six were on view in Victoria Street and were exhibited by a Mr. Johnson, Edison's commercial agent. Edison lamps were shown at the Paris Exhibition in September, 1881, and at the Crystal Palace in 1882. The filaments were made from bamboo fibre—a method which disappeared in favour of the parchmentized thread which came into general use.

To turn for a moment to the position in America; on Sunday, December 21st, 1879, the "New York Herald's" first page announced Edison's lamp, just two months after

its "birth" in his laboratory. "Scientists proclaimed it a fake. Nevertheless the price of gas stocks dropped and stock in the Edison Electric Light Co., soared to $3,500 (£700) a share," we read in "The History of the Incandescent Lamp," by J. W. Howell and H. Schroeder, published in Schenectady, in 1927.

These dates are of academic interest only nowadays; for the legal determination of points of dispute between the Swan Company and the Edison Company in this country has passed into industrial history. But the dates are of keen interest to those of us who like to know the facts, and they reveal the position without bias.

The success which Joseph Swan obtained was almost instantaneous. A company was formed and as soon as he had equipped his own house with electric lamps, the inventor personally supervised the fitting of Swan lamps at Lord Armstrong's house at Craigside near Rothbury and the first commercial house to adopt the new form of illumination was that of James Coxon, the drapers of Newcastle-upon-Tyne.

By 1882, the Mansion House, London, the British Museum, the Royal Academy, and the Savoy Theatre, with many other large buildings, were illuminated by Swan Lamps. They were soon adopted for use at sea, and the SS. "City of Richmond," of the Inman line was equipped by June of 1881.

The parchmentized cotton thread filament reigned supreme until the end of 1883 when Swan devised a new principle and method of filament manufacture—a method that founded another industry altogether, although Swan was indifferent to the subsequent use of the product he had named "artificial silk." In 1883—five years before Count de Chardonnet produced his artificial silk at Besancon - La - Mouilliere, Swan squirted cellulose under slight pressure through a small orifice and formed a continuous, homogeneous thread of indefinite length which was cut and shaped to the required length and carbonized in the usual way.

This invention was responsible for an enormous expansion in the production of low candle power lamps for higher voltages, and it has ever since continued to be the standard method of carbon filament manufacture.

Swan came to London in 1883 and at the Inventions Exhibition in 1885 he showed several small d'oyleys made from fine thread of squirted cellulose—the first artificial silk goods ever displayed.

He left his home at Bromley in 1893 and came to live in London itself. He was elected a Fellow of the Royal Society in 1894, and President of the Institution of Electrical Engineers in 1898. He was first President of the Faraday Society in 1904 and in the same year he received the honour of Knighthood for conspicuous services to science. He received the decoration of the Legion of Honour as early as 1881.

Sir Joseph Swan died on May 27th, 1914, in his 86th year—full of honours, loved by all his associates, a man whose great genius was only equalled by his innate modesty.

—*The Electrician*

Presentations of Resuscitation Medals

ON Thursday, November 22, 1928, at Dundas Substation, Mr. A. J. Douglas of the Operating Department, H.-E.P.C., was presented with the Canadian Electrical Association Resuscitation Medal for saving the life of Mr. P. E. Worden on July 28th, 1928.

Mr. Douglas and Mr. Worden were carrying out certain work at Baden Substation, when Mr. Worden inadvertently received a shock from energized apparatus at 13,200 volts. He was rendered unconscious and not breathing. Mr. Douglas carried out resuscitation by the Prone Pressure Method for about eight minutes before there were any signs of life and it was fifteen minutes before Mr. Worden could breathe without assistance.

E. G. Weeks

A. J. Douglas

The presentation of medal was made by Mr. Wills Maclachlan acting for Mr. P. S. Gregory, President of the Canadian Electrical Association. Mr. H. C. DonCarlos was present and spoke to the men in connection with the prevention of accidents. There were also present: Messrs. J. D. Pace, H. J. Muehleman H. W. Lawson, Geo. Terry, Jack Worden, as well as a number of employees of the H.E.P.C., from the surrounding district.

On Friday, November 23rd, 1928, in the Operating District Office at Belleville Mr. Geo. Weeks received the Canadian Electrical Association Resuscitation Medal for saving the

life of Mr. J. G. Searles on August 4th, 1928, at Trenton Substation.

Mr. Searles and Mr. Weeks were in the Substation and Mr. Searles inadvertently came in contact with a live piece of apparatus, receiving a shock of 4,000 volts to ground. Mr. Weeks immediately started resuscitation which he carried on for five minutes before there was any sign of life and an additional five minutes before Mr. Searles could breathe without assistance.

Mr. Wills Maclachlan presented this medal also for Mr. Gregory, President of the Canadian Electrical Association.

Mr. H. C. DonCarlos was present and spoke in connection with the prevention of accidents. There were also present: Messrs. G. B. Smith, O. R. Thompson, H. Hall, W. Gerrie, Jas. McNamara, as well as a number of employees of the H.E.P.C. from local and outside points.

What Caused the Accident?

A MAN tripped over a loose board, fell and broke his arm. It was a painful and costly injury. It was caused by an accident. What caused the accident?

Such a mishap is usually classified under the head of "Slips and Falls." It is useful, of course, to know what kind of accidents we are having and how many of the various kind; but if we are to find and apply an effective remedy we must go a little farther and try to ascertain the cause of the accident.

The fall was the accident that caused the injury. What caused the fall? The man fell over the board. The board was in the path. The board, being an inanimate object, was not to blame for being there—everybody will admit that. But somebody was responsible for that accident, for the board was placed in the path through some human agency.

We may place the responsibility on the injured man. He should have watched his step, should have looked where he was going. He may come back and say that he was hurrying to do a piece of work, was thinking about what he was going to do and did not expect to find a board in the path. He blames the accident on the fellow who dropped the board.

This man may admit a portion of the responsibility. He was also hurrying, carrying three boards. One of them dropped off and he didn't notice it.

But where was the foreman? He is the responsible man. He admits his responsibility, but says he could not be everywhere at once. If he had seen or heard of the board in the path he would have removed it or had it removed.

We have here a case of poor housekeeping. From the testimony of the injured man and the man whose negligence was the direct cause of the injury it would appear that haste had something to do with the accident.

It all comes back, we believe, to supervisory responsibility. Even though the foreman was not there and did not know that the board had been dropped, he should have had the idea of good housekeeping and safety so thoroughly drilled into his men that the one would almost instinctively have carried the boards so that they would not fall or would have stopped and picked it up when it did fall, and the other man would have watched his step and instead of falling over the board would have stopped a moment and picked it up and put it in a safe place out of the path.

When our foreman and other supervisory men are all thoroughly convinced that "Accidents need not and must not occur" then a mishap of this character should be as rare as one caused by using inadequate tackle to lift a heavy object.—*The Au Sable News.*

17th Annual Safety Congress

During the first week of October, New York City was the meeting place for the world's largest gathering of men and women, meeting together to consider safety, to devise ways and means of preventing accidents and to exchange ideas. This gathering consisted of executives, engineers, operators, representatives of labour, and safety men from the whole North American continent. The magnitude of the Congress is inspiring. Six thousand men and women meeting from 8.30 in the morning until 5 o'clock in the afternoon, talking safety, is a difficult matter for one who has not attended Congress to understand.

To facilitate the work, the meetings are divided into thirty-three sectional groups, each group considering the hazards of that particular section. In addition there are a number of general sessions in the afternoon.

The Public Utility Section in which we were most interested was the largest attended section at the Congress with the exception of one afternoon when Col. Charles A. Lindbergh spoke before the Aviation Section. The papers presented were of a high order. The plants visited were interesting, and the safety exhibit was exceptionally fine. The benefits gained by those who were fortunate enough to participate in the Congress should be inestimable.

O.M.E.A. and A.M.E.U. Convention

at

King Edward Hotel, Toronto

January 23 and 24, 1929

HYDRO NEWS ITEMS

Central Ontario System

The Canadian General Electric has entered on a large building programme in Peterboro and expects to take a greatly increased load in the near future.

* * * *

The question of the purchase of the Peterboro Gas Plant will be voted on by the electorate at the next municipal elections.

* * * *

On January 1st, the City of Oshawa will vote on the question of the purchase of the electrical distribution system and the gas plant from the Commission.

* * * *

Gatineau Power to Central and Eastern Ontario Systems

Delivery of power to the Central Ontario, St. Lawrence and Rideau systems under a contract between the Gatineau Power Company and the Hydro-Electric Power Commission of Ontario has been commenced. The agreement covers the supply of up to 60,000 h.p. at 60 cycles and 110,000 volts. This is transmitted to a transformer station at Smiths Falls where it is stepped down to 26,000 volts for the Rideau system and 44,000 volts for the Central Ontario and the St. Lawrence systems. On November 28th, the first delivery of power from the Gatineau was made when it was successfully operated in parallel first with the Central Ontario and then with the St. Lawrence system. On the following day the Central Ontario and the St. Lawrence systems were supplied at the same time, Gatineau power being in parallel with their previous sources of supply. The Rideau System was added to the group on December 6th.

* * * *

Niagara System

A subsidiary of a large Toronto dairy is building a new milk plant at Princeton for the manufacture of dry and whole milk. This plant will use approximately 60 horsepower in motors and will employ between 30 and 35 people. The annual revenue to the farmers in the vicinity for the purchase of milk by the Company will be in the neighbourhood of $400,000.00 per summer.

* * * *

In one of our rural districts there is a firm manufacturing fertilizer from scrap leather. The scrap leather is roasted in large cylindrical drums and then ground to a powder. The product is sold both in tablet form and in bulk. The power required to operate this plant when doing all operations simultaneously is approximately 20 horsepower.

* * * *

The town of Tillsonburg has taken over the waterworks system formerly operated by a private company. This has been placed in the charge of the Public Utilities Commission

of Tillsonburg, which also operates the electrical utilitiy. The new well-located office of the Public Utilities Commission is a credit to the town.

* * * *

The new street lighting system in the Police Village of Florence was put into operation November 23, 1928. This village is being supplied as a part of the Thamesville Rural Power District.

* * * *

The town of Blenheim has completed the installation of an additional motor and pump in its waterworks plant. The pump is a centrifugal type with vertical shaft and operates in a deep well over 50 ft. below the ground level.

* * * *

The Town Council of Ridgetown has authorized the changing of their ornamental street lighting system on the main street from series to multiple, and the installation of new glassware and larger lamps.

Association of Municipal Electrical Utilities

ELECTION BALLOTT

The ballot for the election of officers for the year 1929, which will take place at the convention at Toronto on January 23rd and 24th, 1929, will show the following names as candidates for the several offices:—

President—A. W. J. Stewart, (Acclamation).

Vice-President—R. L. Dobbin, H. G. Hall.

Secretary—S. R. A. Clement, (Acclamation).

Treasurer—D. J. McAuley, G. J. Mickler.

Directors—E. V. Buchanan, W. R. Catton, D. B. McColl, J. E. B. Phelps, O. H. Scott, P. B. Yates.

District Directors—

Niagara District—J. W. Peart, J. E. Teckoe.

Georgian Bay District—J. R. McLinden, E. J. Stapleton.

Central District—W. E. Reesor, J. E. Skidmore.

Eastern District—A. L. Farquharson, R. J. Smith.

Northern District—T. W. Brackinreid, (Acclamation).

Blind can use Electrical Devices

The application of electricity to various household tasks is proving of extraordinary value in teaching the blind to do many kinds of work hitherto impossible to them, thus giving them a new confidence and a sense of usefulness, declares Ellen F. Ord, home economics authority and teacher of blind children.

Blind pupils learn to use electric percolators, toasters and other cooking appliances readily and safely, and from these they progress to more difficult operations.

"I am convinced that electric appliances solve a real problem for the blind," says Miss Ord. "By using the electric stove they are saved from the danger of serious burns. Boys and girls both use electric toasters of the plate type, and the girls also operate an electric dish-washing machine in the kitchen. Electrical appliances simplify life for the blind, and make what would otherwise be a tedious existance for them a busy and happy life.

—*The Synchronizer.*

Index to Volume XV

PAGE

A. M. E. U. Reports......
...61, 64, 140, 242, 316, 376
Annual Report, Mr. C. A. Magrath's Letter of Submittal of the Twentieth...... 185
Appliance Sales, Electrical..... 258
Application of Hydro-Electric Power to Farm Work,...119, 150, 201, 304, 340, 377, 406
Canadian Electric Code....... 349
Canadian Watthour Meter Practice.................. 46
Commercial Flying........... 308
Demonstration at Provincial Plowing Match............ 345
Development in Line Construction..................... 221
Distribution, A Proposal for Improved Primary......... 281
Electric Strength of Solid Insulation.................. 9
Electrical Appliance Sales...... 258
Electrical Burns and Electrical Shock.................... 14
Electrical Code, Canadian..... 349
Electrical Inspection Under the Commission in Ontario...... 245
Electrical Shock, Resuscitation after..................... 18
Electro-Chemical Industry, Why not an................ 382
Electrolysis and its Mitigation.. 370
Estimates of Power Capacities for Developments on the Mississagi River............ 33
Everything Has to be Sold..... 217
Farm, Hydro on the........... 62
Farm Work, Application of Hydro-Electric Power to...119, ...150, 201, 304, 340, 377, 406
Fuse Design, Some Interesting Factors in................ 172

PAGE

Fuses and Fuse Wires, Protection Afforded by............ 125
Galt Electric Utility.......... 145
Gatineau Power, Inauguration of........................ 325
Gatineau-Toronto Transmission Line, Progress on the.... 117
Grain Elevator at Midland, New 124
Grounding Devices and Equipment.................... 77
Hydro at the Close of its Second Decade.................. 1
Hydro Development in Canada. 6
Hydro-Electric Power Commission of Ontario, Progress of... 81
Hydro-Electric Power to Farm Work, Application of..119, 150, 201, 304, 340, 377, 406
Hydro News Items...29, 142 177, 214, 321, 361, 395, 428
Hydro on the Farm........... 62
Hydro up to the End of 1927, Progress in the Use of....... 327
Housekeeping for Power Houses and Other Public Utilities.... 357
Inauguration of Gatineau Power 325
Interim Report of Special International Niagara Board... 298
Line Construction, Development in.................. 221
Meter Practice, Canadian Watthour..................... 46
Metering Methods, Totalizing and Remote...........158, 206
Mississagi River, Estimates of Power Capacities for Developments on............... 33
Modern Street Lighting....... 235
Mr. C. A. Magrath's Letter of Submittal of the Twentieth Annual Report............ 185
Neon Signs, Survey of......... 351

PAGE

New 5000 kv-a. Synchronous Condenser for Oshawa Condenser Station 404
New 15,000 kv-a. Transformer Station Near Smith's Falls . . . 365
New 44,000-volt Switching Station at Kingston 369
O.M.E.A. Reports 61, 133
Parable of the Range in the Parlour 313
Power 413
Power Factor in the Office 253
Power, Sources of 249
Power System Comparisons 212
Presentation of Resuscitation Medals 425
Progress in the Use of Hydro up to the end of 1927 327
Progress on the Gatineau-Toronto Transmission Line 117
Progress of Hydro Development in Canada 6
Progress of Hydro-Electric Power Commission of Ontario 81
Prone Pressure Resuscitation . . . 355
Proposal for Improved Primary Distribution, A 281
Protection Afforded by Fuses and Fuse Wires 125
Provincial Plowing Match, Demonstration at 345
Public Service and the Psychology of Public Service 85
Public Utilities, Some Notes on the Law Relating to 92
Resuscitation after Electical Shock 18

PAGE

Resuscitation Medal Presented at Sarnia 25
Resuscitation Medals, Presentation of 425
Setting Poles with Dynamite . . . 390
Smiths Falls-Kingston, 110 kv., 60 cycle Transmission Line . . . 397
Some Interesting Factors in Fuse Design 172
Some Factors Involved in Bulk Transmission of Power 36
Some Notes on the Law Relating to Public Utilities 92
Sources of Power 249
Special International Niagara Board, Interim Report of 298
Street Lighting, Modern 235
Survey of Neon Signs 351
Swan Centenary, The 421
Switching Station at Kingston, New 44,000-Volt 369
Synchronous Condenser for Oshawa Condenser Station, New 5,000 kv.-a., ... 404
Television 392
Toronto-Leaside Transformer Station 113, 293
Totalizing and Remote Metering Methods 158, 206
Transformer Station near Smiths Falls, New 15,000 kv-a 365
Transmission Line, Smith's Falls, Kingston, 110 kv., 60 cycle . . . 397
Transmission of Power, Some Factors Involved in Bulk 36
What Caused the Accident? 426
Where do our Waves Go? 129
Why not an Electro-Chemical Industry? 382

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Greetings

The Season's Greetings to All

WE thank you for the patronage we have received from All Hydro Municipalities during the past year and extend to the officials of All Hydro Systems our Heartiest Wishes for a very Merry Christmas and a Happy and Prosperous New Year.

Sales Department
Hydro-Electric Power Commission
of Ontario

THE BULLETIN

VOL. XVI NO. 1

Hydro-Electric Power Commission of Ontario

JANUARY, 1929

Winter Conditions at Hanna Chute Development

HYDRO MUNICIPALITIES

CENTRAL ONTARIO SYSTEM

	Pop.
Belleville	13,030
Bloomfield	625
Bowmanville	3,447
Brighton	1,375
Cobourg	5,459
Colborne	987
Deseronto	1,928
Havelock	1,266
Kingston	22,368
Lakefield	1,146
Lindsay	7,840
Madoc	1,078
Marmora	853
Millbrook	733
Napanee	2,992
Newcastle	619
Newburgh	434
Norwood	711
Omemee	557
Orono	700
Oshawa	20,609
Peterboro	21,790
Picton	3,189
Port Hope	4,567
Stirling	778
Trenton	5,881
Tweed	1,268
Warkworth	500
Wellington	850
Whitby	4,131
Total	131,702

GEORGIAN BAY SYSTEM

Alliston	1,301
Arthur	1,218
Barrie	7,387
Beaverton	975
Beeton	580
Bradford	1,028
Brechin	255
Cannington	896
Chatsworth	326
Chesley	1,803
Coldwater	663
Collingwood	6,237
Cookstown	635
Creemore	603
Dundalk	690
Durham	1,622
Elmvale	600
Elmwood	350
Flesherton	417
Grand Valley	595
Gravenhurst	1,621
Hanover	2,842
Holstein	285
Horning's Mills	350
Huntsville	2,316
Kincardine	2,156
Kirkfield	138
Lucknow	918
Markdale	927
Meaford	3,000
Midland	8,085
Mount Forest	1,825
Neustadt	444
Orangeville	2,503
Owen Sound	12,360
Paisley	749
Penetang	3,896
Port McNicholl	614
Port Perry	1,142
Priceville	
Ripley	670
Shelburne	1,134
Stayner	927
Sunderland	570
Tara	597
Teeswater	807
Thornton	200
Tottenham	557
Uxbridge	1,492
Victoria Harbor	1,462
Waubaushene	600
Wingham	2,470
Woodville	448
Total	86,286

NIAGARA SYSTEM

Acton	2,000
Agincourt	350
Ailsa Craig	535
Alvinston	635
Amherstburg	2,820
Ancaster Twp	4,124
Arkona	363
Aurora	2,307
Aylmer	2,241
Ayr	796
Baden	710
Barton Twp	7,774
Beachville	503
Belle River	580
Blenheim	1,528
Blyth	692
Bolton	656
Bothwell	630
Brampton	4,406
Brantford	32,786
Brantford Twp	7,301
Brigden	400
Bridgeport	500
Brussels	872
Burford	700
Burgessville	300
Caledonia	1,450
Campbellville	200
Cayuga	784
Chatham	15,525
Chippewa	1,450
Clifford	469
Clinton	1,941
Comber	800
Cottam	333
Courtright	416
Dashwood	350
Delaware	350
Dorchester	400
Drayton	
Dresden	1,393
Drumbo	375
Dublin	218
Dundas	5,054
Dunnville	3,569
Dutton	870
Elmira	2,610
Elora	1,199
Erieau	500
Erie Beach	250
Embro	463
Essex	1,753
Etobicoke Twp	15,000
Exeter	1,583
Fergus	1,815
Fonthill	500
Ford City	13,046
Forest	1,427
Galt	13,332
Georgetown	2,554
Glencoe	779
Goderich	4,287
Granton	300
Guelph	19,230

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Progress of Hydro-Electric Power Commission During 1928

By C. A. Magrath, Chairman, H.E.P.C. of Ont.

IN RESPONDING to the request for a brief statement illustrative of the progress that has been made during the past year in the work of the Hydro-Electric Power Commission, I shall commence by stating that the Commission during the past year has supplied up to 1,000,000 horse-power of electrical energy, and that no less than 558 municipalities, including 25 cities, 84 towns, 216 villages and police villages and 233 townships, are now receiving their electrical service from the widespread transmission networks operated by the Commission.

There are two features which disclose the progress of the publicly-owned electrical undertaking of the municipalities of Ontario. One is the natural growth which takes place year by year, due to the normal increases in population, in industrial activities, in new buildings, in new streets to be lighted, etc.; and the other falls under the general heading of new physical installation, and comprises such features as new developments, the extension of existing plants and the erection of new transmission lines.

Owing to the fact that the "Hydro" utilities do not close their books until the end of the calendar year, it is not possible to do more than indicate the general progress. There has been a steady increase in the utilization of electrical apparatus and equipment in the fields of industrial, commercial and domestic use. In the homes of Ontario, electrical appliances of many kinds are rapidly becoming standard equipment.

Increased Power Supplies

During the year, the increased demand for electrical energy has aggregated about 80,000 horsepower. In the matter of the sources of the

CONTENTS

Vol. XVI **No. 1**

January, 1929

	Page
Progress of Hydro-Electric Power Commission During 1928	1
Niagara Convention and Protocol	5
Hydro-Electric Progress in Canada During 1928	9
Power Stations in Border Cities District	15
New 5000 kv-a. Synchronous Condenser in Service at Oshawa	17
Early Types of Electrical Fittings	19
Hydro-Electric Installations	22
Hydro News Items	26

supply of electrical power, Oct. 1, 1928, saw the opening of the new 220,000-volt transmission line conveying power from the Gatineau River in the Province of Quebec to the Commission's new receiving station at Leaside, on the outskirts of Toronto.

This high-voltage transmission line begins at the Paugan Falls hydro-electric generating station of the Gatineau Power Company, situated some 35 miles above the mouth of the Gatineau River, near Ottawa, and about 28 miles from Fitzroy Harbor, on the Ottawa River, where the transmission line enters Ontario. From this point it takes a practically straight line over rough country until it reaches Millbrook, a few miles south of Peterborough, and continues thence to Leaside, tying in with the Niagara system at 110,000 volts, and serving also the east end of Toronto with a supply of electrical energy at 13,200 volts. The preliminary survey for the route of the transmission line was performed by means of aerial photography. In the 202 miles of line in Ontario there are 994 towers or slightly less than five towers to the mile, the longest span having nearly half a mile between towers. Allowing for all overheads, interest during construction, administration, etc., the expenditures to-date indicate that the undertaking will be completed well within the estimates of the Commission's engineers. It may be recalled that the Commission has contracted for the supply to it of 360,000 horsepower from the Ottawa watershed.

Rural Electrical Service

No feature of the Commission's work during recent years has attracted and is attracting more attention than what is being accomplished in the field of rural electrical service. And on this occasion one cannot do better than make special and fuller reference to this important field of development.

The influence upon the economic life of the Province of Ontario of the rural electrical service supplied through the Commission, already a factor of great social importance, is taking its place as one of the outstanding achievements of Ontario's municipally-owned electrical undertaking.

Although the first rural lines of the Commission were built in 1912, it was not until after the passing of the amended legislation of 1924 that the present era of expansion in rural electrification experienced its great impetus. In 1921, only 500 miles of rural primary-line had been constructed; in 1923 about 1,000 miles were in use, in 1925 there were 1,500 miles,

and at the end of 1927 some 3,000 miles of line were supplying service to 25,000 customers. At the present time the Commission is operating 130 rural power districts in different parts of the Province and serving some 31,000 consumers by means of primary transmission lines aggregating 4,100 miles in length, During the past three years the Commission has been extending and constructing rural primary transmission lines at the average rate of nearly three miles per day. This is, indeed, remarkable progress, and is cumulative evidence that the rural electrical service supplied by the Commission with the co-operation of the Government is highly acceptable to the rural communities of Ontario.

PROVINCIAL "GRANT-IN-AID"

It is a gratification to the Commission and to the citizens of the Province that the Provincial "grant-in-aid" respecting rural electrical service is working out so satisfactorily. The grant-in-aid, given by the Province to encourage the extension of electrical service to rural districts, is in pursuance of a long-established Government policy of promoting in various ways the basic industry of agriculture.

Ths policy has frequently found expression in such matters as the establishment of agricultural schools, colleges and experimental farms, in assistance for road-building, and in other ways. Under present legislation, the grant-in-aid provides half the capital cost of primary and secondary lines and equipment in rural power districts. These transmission lines receive power from the distributing centres of city, town or village—as the case may be—and deliver it to the boundaries of the rural consumers' property. The grant-in-aid should, of course, not be confused with the rates for service. Having made its contribution to the capital cost, the Government's participation in the rural operations to which the grant applies ceases.

In their annual rates, the rural consumers pay the whole of the cost of power as delivered to the boundary of the rural power district; the whole of the operating and administrative expenses chargeable to the rural power district; the reserves for renewals and contingencies on the whole of the transmission lines and equipment, as well as interest and sinking fund applicable to half the capital investment for the primary and secondary lines and equipment. The net effect of the Provincial assistance is most helpful to newly established rural power districts, and has contributed substantially to the extension of service to less-densely populated districts and to those more remote from transmission lines. The capital investment in the rural power district transmission lines and equipment is now in excess of $8,500,000.

In carrying out its work in this rural branch of its activities, the Hydro-Electric Power Commission has developed and standardized highly economical methods of rural line construction and operation which have substantially reduced the cost of supplying rural electrical service.

POWER DRIVEN FARM MACHINERY

The extensive rural distribution of electricity is opening up new markets for manufacturers of electrically-driven machinery, and the influence of

rural electrification is not confined to electrical motors and appliances, but extends to all the operations of the farm. The limitations which are necessarily imposed upon the rural user of electricity with respect to his maximum loads is stimulating research into the efficiency of farm power-driven machinery. It is a common practice to install machinery larger than is really necessary, but when the question of electric drive has to be considered, it is frequently found that the work may be accomplished more profitably by smaller machines requiring less power. As rural distribution of power extends, power-driven machinery will be employed with increasing regularity, and this will open up the opportunities of a large field for co-operative effort to design and secure a better type of farm equipment specially adapted for electric drive.

A similar process will take place in the case of rural industries, which include saw and grist mills, cheese and butter factories, brick and tile yards, stone quarries and gravel plants. These are often carried on with antiquated equipment, and the coming of electrical service has caused many rural industries to develop and expand.

Increased Capital and Reserve

With respect to the general operations of the Commission, the extensions and new installations naturally result in an increase in the capital investment in the whole undertaking. At the present time the total investments of the Hydro-Electric Power Commission in collective undertakings made by the Commission on behalf of the co-operating municipalities and the investments made by the municipalities themselves in distributing systems and other electrical assets aggregate nearly $300,000,000.

Year by year, under the conservative policy which characterizes the financial operations of Ontario's co-operative municipal electrical enterprise, the reserves of the undertaking have been steadily increasing. This is true, both with respect to the collective investments of municipalities in generating stations, transmission station and transmission lines, and with respect to their local investments in distributing systems and other assets. Moreover, the reserves are increasing today at a more rapid rate than previously. As stated in the twentieth annual report of the Commission, these reserves at the end of October, 1927, aggregated more than $65,000,000. The forthcoming annual report will show reserves aggregating about $73,000,000. In conclusion, it may be stated that it has been and is a gratification to those responsible for the administration of the Commission to know that its supply of electrical energy has kept pace with the demands arising from the prosperity enjoyed by all portions of the Province of Ontario.

Niagara Convention and Protocol

REFERENCE was made in the Press, early this month, to the major features embodied in the Niagara Convention and Protocol, between Canada and the United States, signed at Ottawa on January 2nd, looking to the preservation of the scenic beauty of Niagara Falls and Rapids.

This Convention represents the culmination to date of the investigatory work which the Governments of Canada and the United States have had underway in the Niagara River for the past two years for the purpose of determining how the scenic beauty of Niagara Falls and Rapids can best be maintained, and by what means and to what extent the impairment thereof by erosion or otherwise can be overcome and, consistent with the preservation of the scenic beauty of the Falls and Rapids, of determining what quantity of water might be permitted to be diverted from the river for power purposes. Effect is being given by this Convention to the recommendations of the Special International Niagara Board, appointed in 1926 by the two Governments to investigate and report on this matter.

Provisions of the Convention and Protocol

The Convention provides in Article 1, that remedial works shall be constructed in the Niagara River above the Niagara Falls designed to distribute the water of the river so as to ensure at all seasons unbroken crestlines on both the Canadian and American Falls and an enhancement of their present scenic beauty.

The most outstanding effect of this provision will be the reclothing with a substantial flow of water of the two flanks of the Horseshoe Falls which have been so long denuded. Exposed shoal will be removed and a better distribution of water secured throughout the rapids and over both falls. The brilliant green colour of the Horseshoe Falls, which forms such an outstanding scenic feature, will be completely preserved and the entire scenic values of the spectacale as a whole greatly enhanced.

Article 2, provides that concurrently with the construction and tests of the remedial works and as a temporary and experimental measure, there will be permitted diversions of waters of the Niagara River additional to the amount specified in Article 5, of the Boundary Waters Treaty of 1909, to the extent of 10,000 cubic feet of water per second on each side of the river. These additional diversions shall only be allowed during the winter or non-tourist season, beginning on the first day of October and ending on the thirty-first day of March of the following year. This provision for diversion shall terminate seven years from the date of the initial additional diversion authorized.

The Protocol accompanying the Convention provides the machinery for giving effect to its provisions. In this Protocol the practical co-operation of the Hydro-Electric Power Commission is manifested.

The Protocol provides that, the construction of the remedial works authorized in Article 1, of the Convention, the provision for the cost

and for the control thereof, as well as the control of the diversions of water authorized in Article 2, of the Convention, shall be carried out in accordance with the recommendations of the Special International Niagara Board as set forth in its report dated the 3rd May, 1928.

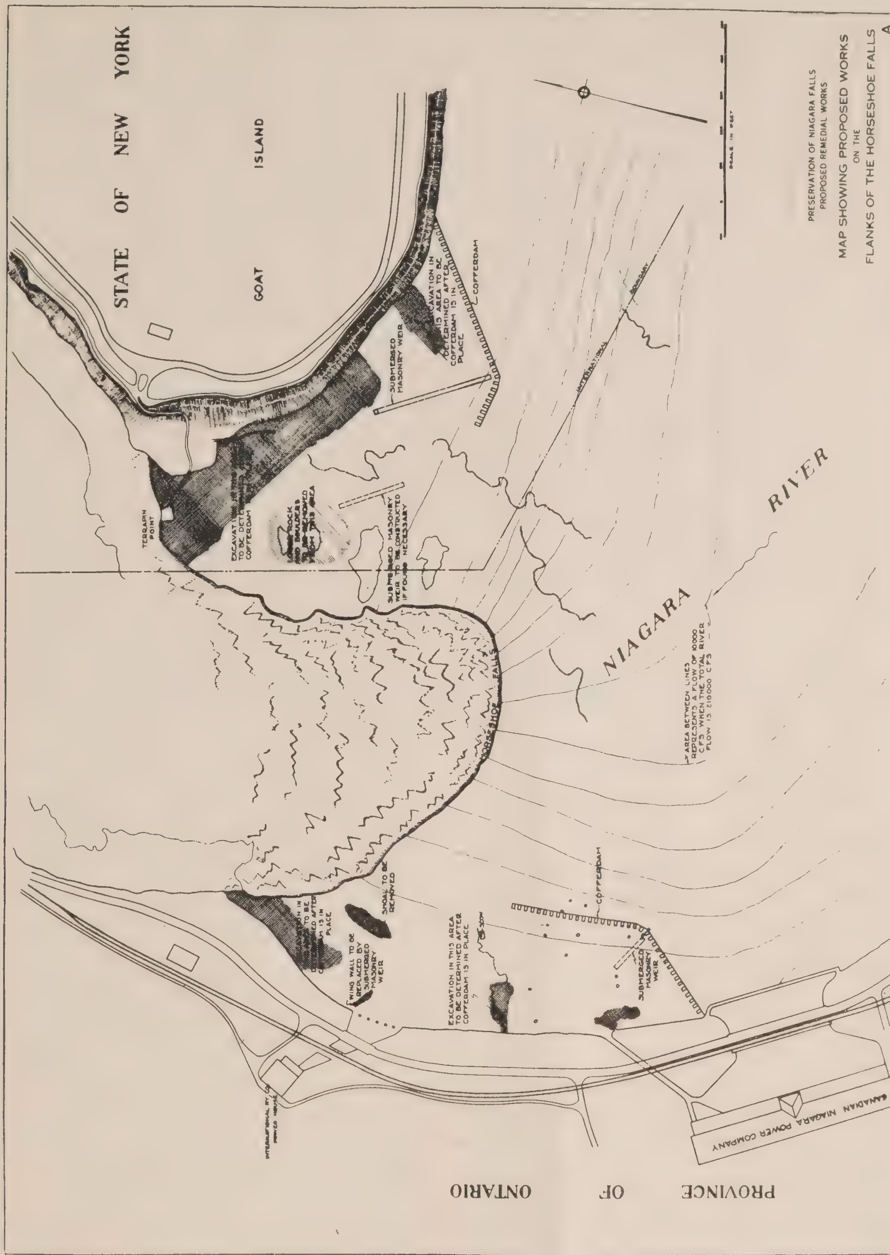
This report recommends for acceptance by the two Governments, under stringent conditions, the joint proposal made by the Hydro-Electric Power Commission of Ontario and the Niagara Falls Power Company of Niagara Falls, New York, offering to construct the remedial works at their own cost, conditioned upon their being permitted to utilize in their existing power stations the 10,000 cubic feet per second additional water which it is intended should be withdrawn from each side of the river during the winter season for the purposes of testing the effectiveness of the remedial structures to redistribute the water and so enhance the scenic values, and also to determine their value to offset the effect of additional withdrawals. It might be added that the existing water passages of the power plants on both sides of the river afford the only means by which actual experimental withdrawals from the river can be effected.

The Special International Niagara Board recommended the acceptance of the above joint proposal, subject to the two Governments retaining complete supervision through the International Board of Control (appointed by the two Governments in 1923) over the design, the construction and the sequence of construction of the remedial works, and exercising further, complete supervision and control over the additional water permitted to be diverted and subject furthermore to the Special Niagara Board passing upon all scenic effects resultant from the construction of the remedial works.

The joint proposal of the Hydro-Electric Power Commission of Ontario and the Niagara Falls Power Company of New York, in respect to the construction of remedial works at Niagara Falls was submitted to the Special International Niagara Board for consideration following the Interim Report of that board of December 14th, 1927, (see the Bulletin, September 1928). In that report certain initial remedial measures were recommended which might, with advantage, be undertaken at Niagara Falls in the immediate future.

Under those circumstances, the Commission and the Company jointly prepared drawings showing works in the Niagara River which conform to the recommendations of the Special International Niagara Board in its Interim Report. A description of such works and estimates of cost are also given in the joint proposal, the Commission and the Company having available construction forces which will enable them to construct such works efficiently, quickly and at minimum expense.

In view of the foregoing, the Commission and the Company jointly offered to construct at their own expense the initial remedial works shown on the said drawings under strict and complete Governmental supervision and control, conditional upon their being permitted to utilize during the Winter season only, ten



thousand cubic feet per second on each side of the river additional to that presently permitted to be diverted under the Boundary Water Treaty of 1909, the additional water to be used in the power stations and water passages already constructed.

On the American side, a cofferdam will be built commencing at a point on Goat Island about 1,100 feet upstream from Terrapin Point and will be extended out into the river, in a direction at an angle of about 45° to the shore line, for a distance of about 400 feet. At that point the cofferdam will be extended downstream for a distance of about 150 feet. This cofferdam will unwater the bed of the river below it and a section of the crest of the Horseshoe Falls for a distance of about 600 or 700 feet from Terrapin Point. Within the area thus unwatered, the bed of the river will be excavated to the extent and depths to be determined by the Niagara Control Board and one or more submerged masonry weirs will be built approximately in the positions shown on the drawing. The areas crosshatched indicate approximately the extent of the excavation, and the dotted lines the length and position of the weirs. The depth of the excavation will not exceed 3 or 4 feet.

The cofferdam will be constructed of timber cribs, or of timber cribs and stop logs, in such a manner that the stop logs or portions of the cribwork may be removed and the water allowed to flow over the unwatered area so that the effect of the works may be observed before the cofferdams shall be removed. It is intended that the submerged masonry weirs will deflect some of the water from its natural channel and the excavated areas will cause a sufficient quantity of water to flow close to the shore of Goat Island and over the crest of the Falls in the vicinity of Terrapin Point. If the observed effect is not all that may be desired, the stop logs or cribwork can be replaced and such additional work done as may be necessary.

On the Canadian side, a cofferdam will be built commencing at a point just below the intake to the forebay of the Canadian Niagara Power Company's plant and will be extended out into the river in a direction about 45° to the shore line for a distance of about 300 feet. At that point the cofferdam will be turned downstream for a distance of about 400 feet. This cofferdam will unwater the bed of the river below it and a section of the crest of the Horseshoe Falls for a distance of about 400 feet from its extremity at the Canadian shore. Within this area excavations will be made and submerged weirs built, as directed by the Board, in the same manner as that described above to be done on the American side. The crosshatched areas and dotted lines indicate approximately the areas to be excavated and the length and position of the weirs to be built. It is intended that the effect of these works will be to cover the Canadian end of the Horseshoe with a sufficient quantity of water.

It is also proposed to build a submerged weir in the Chippawa-Grass Island Pool for the purpose of raising the level of the pool so as to increase the flow of water down the American channel and over the American Falls. This weir is to be located about 1,700 feet upstream from the intake to the plant of the Ontario Power Company and will extend out into the river for a distance of about 2,200 feet. It is designed to be built of loose rock fill. It is intended that the weir will raise the standard low water level of the

Chippawa-Grass Island Pool approximately one foot, which will be sufficient to increase the flow over the American Falls by about 2,500 to 3,000 cubic feet per second.

Recommendation of Special Niagara Board

The Special Niagara Board reviewed this joint proposal of the Commission and the Company and recommended its acceptance by the two Governments subject to stringent conditions as to absolute and complete governmental control throughout, both as to the design and construction of the remedial works and also as to the withdrawal of the additional amounts of water proposed during the winter season.

The construction of these remedial works is in exact accord with the recommendations of the Board made in its interim report and will constitute a practical demonstration on the Falls themselves of:

First,—The effectiveness of the remedial works to secure a better distribution of water along the entire crestline of the two falls and thereby enhancement of the scenic values of the spectacle as a whole; and,

Second,—The effectiveness of the remedial works to offset additional withdrawals of water without the impairment of the scenic values.

Hydro-Electric Progress in Canada During 1928

(*Extract from Bulletin No. 1242, Dominion Water Power and Reclamation Service, Department of Interior, Canada*)

THAT the year 1928 was one of the greatest in the history of water power development throughout the Dominion is disclosed in the annual review of hydro-electric progress by the Dominion Water Power and Reclamation Service of the Department of the Interior.

During the year the water wheels or turbines actually installed and brought into operation totalled slightly more than 550,000 horse power, bringing the total installation in the whole Dominion to a figure of 5,328,000 horse power. Additional to this large increase there were many large undertakings under active construction, some of which were nearing completion at the end of the year while others were in their initial stages. The combined installations of these projects total to more than 1,200,000 horse power. There are also many large developments in prospect, a number of which will undoubtedly be undertaken in the coming year.

The effect upon the country's prosperity of this great programme of construction work is evident when it is stated that for the actual development, transmission and distribution of the new power capacity installed in 1928, together with that at present actively under construction, not less than $330,000,000 will be required. Moreover, it has been estimated that for every dollar so expended six dollars are required to

apply this power to its ultimate uses so that on this basis, a total expenditure of probably $2,300,000,000 will result throughout the Dominion as a result of this new development.

During 1928 every province was represented in the year's activities and, while Quebec stood first in works of magnitude, the widespread nature of development is perhaps the most interesting and significant feature. Saskatchewan appears for the first time with a hydro-electric project under way on the Churchill river for the supply of the new northern mining area, while British Columbia, Alberta, Manitoba, Ontario and the Maritime Provinces are all represented with important new undertakings or substantial additions to existing developments. The principal activities in each of the provinces are given some detail in the following paragraphs.

British Columbia

In British Columbia new water power equipment to the extent of 79,560 h.p., was installed during 1928, while projects actually under construction or in early prospect involve installations which will ultimately add more than 350,000 to the province's total.

The West Kootenay Power and Light Company, Limited, practically completed its 75,000 h.p., development at South Slocan on the Kootenay river. The output from this plant will be added to that from the other two plants of the Company on the same river to serve the mining industry of the Rossland district. The Company also completed a new outdoor switching station capable of taking care of 150,000 h.p., and constructed a 60,000 volt transmission line, 30 miles in length from Bonnington to Ymir. The British Columbia Power Corporation has been very active throughout the year in carrying on development work through its subsidiary companies. Of these the Burrard Power Company Limited, brought into operation on May 15th the Alouette plant of 12,500 h.p. This plant is automatically operated from the Stave Falls station. The Bridge River Power Company made good progress on the driving of the two and a half mile tunnel which will bring the waters of Bridge River through the mountain divide to the power station on Seton Lake. The Vancouver Island Power Company carried forward work on the enlargement and improvement of its Jordan River undertaking.

Other activities during the year included the virtual completion of the initial stage of Shuswap Falls development of the West-Canadian Hydro-Electric Corporation on the Shuswap River with one unit of 3,800 h.p. The Cork Province Mines installed 435 h.p., on Keen creek for use in the mines, while the Whitewater Mines Limited, completed a 280 h.p., development on Whitewater Creek also for mining purposes. A small installation of 45 h.p., was made on Stein River for a private estate near Lytton.

Alberta

In Alberta, the Calgary Power Company, in the late summer, commenced the construction of a development at the Ghost site on the Bow River about thirty miles west of

Calgary. This plant will have an installation of two 18,000 h.p., units and the dam which is being erected will provide a head of 105 feet and pondage of 45,000 acre-feet.

Saskatchewan

An interesting feature of this review is the inclusion for the first time of the Province of Saskatchewan in hydro-electric activity. The Churchill River Power Company, Limited, a subsidiary of the Hudson Bay Mining and Smelting Company has secured a license to develop the Island Falls site on the Churchill River in the northern part of the province, the power from which will go to supply the needs of the Flin Flon Mine, the property of the parent Company. The Island Falls power station is designed to include six units of 14,000 h.p., each, three of which it is expected will be in operation before the end of 1930. A transmission line some 65 miles in length will carry this power to Flin Flon.

Another matter of outstanding interest in the province was the submission to the Saskatchewan Government of the report of the Saskatchewan Power Commission favoring a policy of government ownership and operation of power utilities in the southern part of the province. The report proposed that the government acquire by purchase the municipal power plants at Regina, Moose Jaw and Saskatoon, which, operated under a central administration, would form the nucleus of an ultimate provincial system. The Government has announced a power policy based on this report and as a start is negotiating with the City of Saskatoon for the purchase of the City's power plant.

Manitoba

The year was one of outstanding note in Manitoba as it saw the completion of one large plant and the initiation of two others on the Winnipeg River.

The Manitoba Power Company completed the installation of units Nos. 5 and 6 in its Great Falls station, each of 28,000 h.p., thus bringing the plant to its ultimate designed capacity of 168,000 h.p.

To meet the rapidly growing power demand on its system the Winnipeg Electric Company through a subsidiary "The North Western Power Company" carried out preliminary work in connection with the development of the Seven Sisters site on the Winnipeg River. The power station is designed for an ultimate installation of 6 units of 37,500 h.p. each under a head of 66 feet, making a total capacity of 225,000 h.p.

The City of Winnipeg Hydro-Electric System is also in need of a supply of power additional to that furnished by its 105,000 h.p., development at Point du Bois on the Winnipeg River and work has been initiated in the development of the Slave Falls site about six miles downstream from Point du Bois. The Slave Falls power station will ultimately contain 8 units each of 12,500 h.p. capacity or a total of 100,000 h.p.

For the further regulation of the flow in the Manitoba reach of the Winnipeg River an arrangement was made early in the year between the Dominion Government and the Government of the Province of Ontario

whereby a storage dam is being built by the Ontario Government at the outlet of Lac Seul, the cost of which is being shared between the Dominion and Ontario.

Ontario

In Ontario the outstanding event of the year was the completion and the bringing into operation on October 1st of the 220,000 volt transmission line between the Ottawa River and Toronto, over which power purchased from Gatineau Power Company is brought to augment the supply of the Commission's Niagara system. The initial load carried by this line was 80,000 h.p., and the contract calls for an ultimate supply of 260,000 h.p. The Commission also completed the construction of a new 110,000 volt line leading from the Ottawa River near Ottawa, to Smiths Falls and Brockville to supply Ottawa and its Eastern Ontario system. The power for this line is also secured from Gatineau Power Company, the contract calling for delivery of 60,000 h.p., with an additional 40,000 h.p., in reserve at the call of the Commission. The line was placed in operation late in November with an initial load of 6,000 h.p.

Other activities of the Commission included the construction of an 1,800 h.p., development to serve the Nipissing system at Elliott Chute on the South River, which will be placed in operation in the spring of 1929, and a 2,200 h.p. development at Tretheway Falls on the South Muskoka River to augment the supply of the Georgian Bay system. The latter is also expected to be ready for operation in the spring of 1929. Studies have also been continued in connection with development on the Musquash River for the further supply of the Georgian Bay system. The Commission is also supervising the construction of the dam at the outlet of Lac Seul which has already been mentioned in the Manitoba section. In addition to providing storage for the benefit of the English and Winnipeg River powers facilities for the development of power will also be provided at the dam itself which is of potential interest to the nearby Red Lake mining district.

Apart from the activities of the Commission, hydro-electric development has been actively carried forward by other interests. At Smoky Falls on the Mattagami River the Spruce Falls Company completed and brought into operation a 56,250 h.p. development, the power from which is carried over a 50 mile transmission line to the Company's pulp and paper mill at Kapuskasing. The Ontario and Minnesota Power Company completed its Calm Lake development on the Seine River in June with an installation of 13,200 h.p. This power is brought to Fort Frances for use in the pulp and paper industry. The Dryden Paper Company completed and placed in operation in October a 2,000 h.p. development on the Eagle River, while the International Nickel Company carried forward the construction of a 28,200 h.p., development at the Big Eddy dam on the Spanish River which is expected to be ready for operation early in 1929.

Quebec

New plants and extensions to existing plants actually placed in operation during 1928 added more than

300,000 h.p. to Quebec's hydro-electric installation; this additional capacity being mainly found in the new Paugan plant of the Gatineau Power Company (a subsidiary of the Canadian Hydro-Electric Corporation, Limited, the Canadian power unit of the International Paper and Power Company) and, in additional units installed at the plants already in operation at Shawinigan, at Isle Maligne, and Quinze Dam.

The Paugan plant of the Gatineau Power Company was placed in operation with six units in September 1928; each unit is of 34,000 h.p., giving a present installation of 204,000 h.p., while two additional units are provided for, which will bring the ultimate capacity of this station to 272,000 h.p. The same Company is also installing a fourth unit in each of the other two plants lower down on the Gatineau River, the capacity of these additional units being 34,000 h.p., at Chelsea and 24,000 h.p., at Farmers; both new units are to be in operation early in 1929. Gatineau Power Company is also adding a second unit of 25,000 h.p. to its Bryson plant on the Ottawa River, the new unit to be in operation early in 1929.

The Shawinigan Water and Power Company has added a 43,000 unit (No.7) in No. 2 Shawinigan plant, bringing the capacity of this plant to 178,500 h.p., No. 8 unit of the same capacity is being installed to be in operation in March 1929.

The Quinze Power Company has added 2 units of 10,000 h.p. each to their plant on the Quinze River, Upper Ottawa, the total installation now comprising 4 units.

On the Saguenay River the Duke-Price Power Company has added unit No. 11 of 45,000 h.p. to the Isle Maligne plant.

Other installations placed in operation during 1928 include an addition of 2,400 h.p., by Ayers Limited, on the North River at Lachute, a 1,050 h.p., hydro-electric plant completed for the Cie. Electrique de la Sarre on La Sarre River near the town of the same name, another of 800 h.p., on Belle River in the Saguenay district for the St. Jerome Light & Power Company, a 760 h.p., addition to the site of Sherbrooke Water Works plant on the Magog River, the addition of 182 h.p. by the Barrett Company, Limited, at the former McArthur site on Assomption River at Joliette, the Cie Electrique Ste. Catherine's 150 h.p. plant on the outlet of Lake St. Joseph at Ste. Catherine, and the Cie Electrique de Charlevoix's 140 h.p. plant on Boudreault Creek at Les Eboulements Wharf.

New Brunswick

The year was notable in New Brunswick as it marked the completion of the initial stage and the bringing into operation on October 1st of the Grand Falls development on the St. John River of Saint John River Power Company, a subsidiary of Canadian Hydro-Electric Corporation. This development, which is the largest in the Maritime provinces, is designed to include four 20,000 h.p. units operating under a head of 130 feet. One of these was placed in operation on October 1st, 1928 while two others are being installed, the first to be in operation early in

1929 and the second probably by autumn of that year.

The Fraser Companies Limited, who were the first customers for Grand Falls power, have contracted to take 20,000 h.p. for their mills in New Brunswick. Most of the remaining power at Grand Falls will go to pulp and paper mills to be erected by the New Brunswick International Paper Company. One of these mills, with a daily capacity of about 500 tons of newsprint paper, will be located at Dalhousie on Chaleur Bay and will be supplied over a 132,000 volt transmission line approximately 110 miles in length.

Nova Scotia

In Nova Scotia the year was one of widespread activity in hydro-electric development, new installations to the extent of 8,440 h.p. being brought into operation, while a number of new developments were undertaken which, when completed, will add 34,550 h.p. to the Province's total.

The outstanding construction was that carried forward by the Nova Scotia Power Commission. The Sandy Lake development of the St. Margaret Bay system was brought completely into operation in June by the installation of the second generator. The two turbines of 2,500 h.p. each were installed in 1927 and were credited to that year. On the Mersey river the Commission has three developments under construction which will have a combined capacity of 31,050 h.p., the first at Upper Lake Falls with 7,750 h.p., under an average head of 30 feet, the second at Lower Lake Falls with 10,600 h.p., under a head of 48½ feet and the third at Big Falls with 12,700 h.p., under a head of 58½ feet. In addition the Commission took over and reconstructed the development of the town of Liverpool at Guzzle Falls on the Mersey River. Two units of 700 h.p., each were installed, replacing the old installation of 700 h.p. On the Tusket River at Tusket Falls the Commission has a development of 3,000 h.p. capacity under construction comprising three units of 1,000 h.p. each.

Other activities in Nova Scotia included the completion of a 4,350 h.p. development of the Avon River Power Company at Avon River Falls.

Prince Edward Island

In Prince Edward Island the Montague Electric Company Limited, placed in operation its new 160 h.p. development.

Power Stations in Border Cities District

DUE to the rapid growth of population and industries in the Municipalities bordering on the Detroit River the Commission has found it necessary to construct distributing stations to take care of the distribution of power to those districts outside of the Cities of Windsor and Walkerville. The first of such stations was constructed in 1924 at Sandwich to serve the town of Sandwich and a portion of the Sandwich rural district. The second station was built in 1926 at Riverside to supply the town of Riverside and the Municipalities of Tecumseh and St. Clair Beach. The third station was erected in 1928 at Ford City to feed the major portion of the Municipality of Ford City which had previously obtained power from the Walkerville Municipal Station.

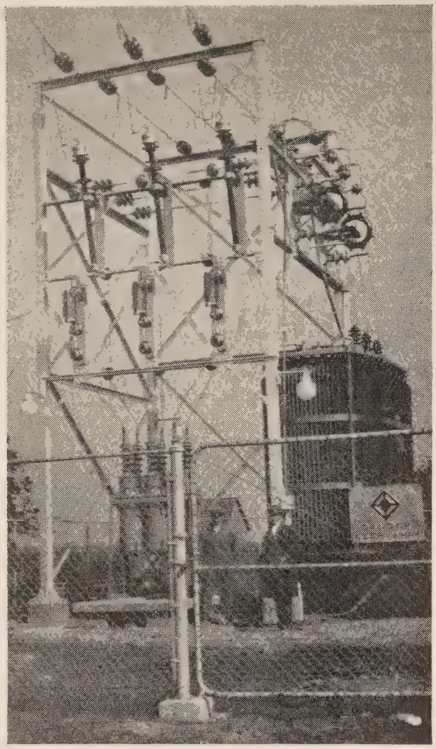
All of the above three stations consist of outdoor structures for supporting the high voltage equipment with outdoor three phase 26,400 volt transformers. At Sandwich the structure is of wood pole construction but the other two stations have steel structures. The 4,000 volt equipments are housed in brick buildings 20 ft. by 20 ft. at Sandwich and Riverside and 20 ft. by 25 ft. at Ford City.

Sandwich Station was first placed in service in June 1924 with one 1,500 kv-a., 3 phase transformer and two 4,000 volt feeders.

Additional equipment has since been provided and at the present time this station has 4,500 kv-a. transformer capacity and three 4,000 volt feeders.

The Riverside Station was first placed in service in June 1926, with one 1,500 kv-a. 3 phase transformer and two 4,000 volt feeders installed. A second 1,500 kv-a. transformer and the third 4,000 volt feeder have since been added.

Riverside Distributing Station. Building for 4000 volt feeder equipment.



Riverside distributing station. Incoming line equipment and transformer before second unit was added.

Ford City Station was placed in service in December 1928. There is now installed one 3,000 kv-a., 3 phase transformer and five 4,000 volt feeders and provision is made for addition of transformers as required.

It was stated above that Sandwich Station served a portion of the Sandwich Rural Power District. Load growth in this district has necessitated the construction of a pole type station in the Municipality of La Salle to serve La Salle and the portion of the rural district in that neighborhood. This station was also placed in service in December 1928, and consists of three 150 kv-a. single phase, outdoor transformers and a small galvanized iron building for housing the metering equipment for two 4,000 volt feeders.

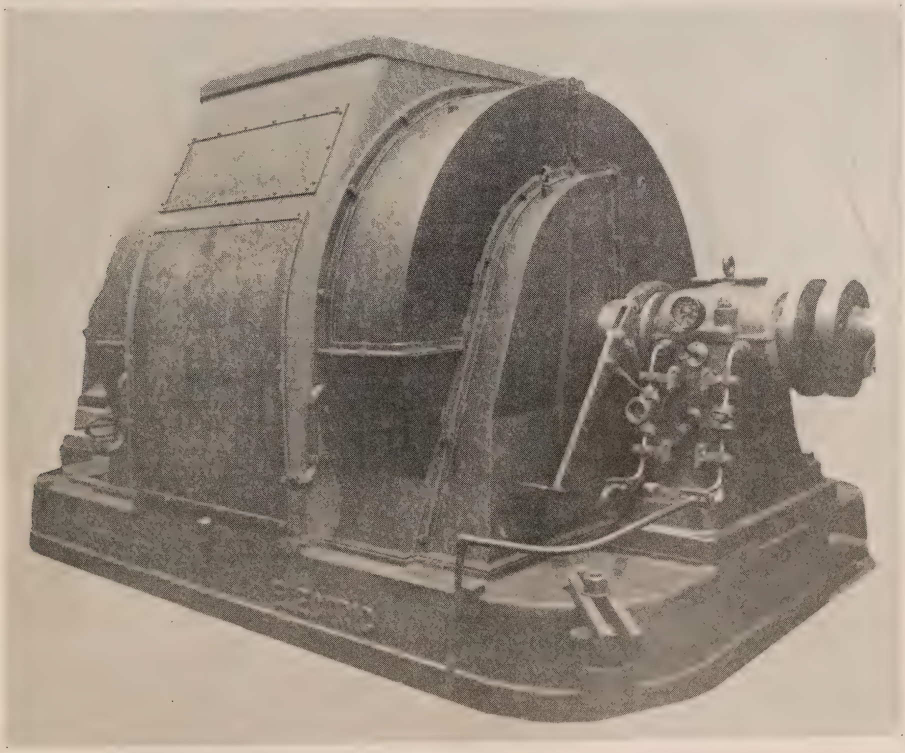
The above paragraphs do not cover additional installations made in Windsor and Walkerville to meet load requirements in those cities. In Windsor in 1927 the Municipality constructed a new station which was described in the BULLETIN of September 1927. The Municipality of Walkerville is now proceeding with an extension to and remodelling of its substation, and with a new station in the southerly part of the city to serve industrial and other loads. The initial capacity of this new station is 3,000 kv-a. and the layout will provide for growth to an installed capacity of at least 18,000 kv-a. A more detailed description of the new station will be prepared after the initial part of the station is completed.

New 5000 Kv-a. Synchronous Condenser in Service at Oshawa

INSTALLATION of the new 5,000 kv-a. synchronous condenser at Oshawa described in the December 1928 BULLETIN was completed on January 3rd, 1929 and it was placed in operation on that date. The machine is started by applying approximately 25 per cent. voltage to the stator with the rotor short circuited by a discharge resistance. An amortisseur winding on the rotor causes the condenser to start as an induction motor, which it does with a current input from the line of less than 30 per cent. of full load current.

After the unit is up to speed the field is closed on the exciter and field current adjusted to the proper value. The starting breakers are then opened and the running breaker closed. Adjustment of the leading or lagging kv-a. taken by the machine is obtained by means of the exciter field rheostat on which acts an automatic voltage regulator. The action of this regulator is such as to so adjust the field current of the machine to produce whatever leading or lagging kv-a. is necessary to maintain the desired bus voltage at Oshawa.

The condenser was started up without incident and although its rated speed is 1,200 rev. per. min., it operated with a noticeable lack of



vibration and noise and with very low bearing temperatures.

While most of the acceptance tests were carried out in the Manufacturer's factory it was found necessary to have the heat run, V curve and high potential tests carried out after installation. The working out of these tests presented some rather interesting features.

The heat run was made by loading the machine to full rated kv-a., use being made of the older 1,200 kv-a. condenser, operating with lagging current, to keep the bus voltage constant during the test.

The time necessary to produce a constant temperature was reduced by having the machine run at as high a load as feasible during the previous day and night with a large percentage of the cooling air shut off. This resulted in a constant temperature within three hours of placing full load on the machine.

Temperature of the stator coils was observed by means of a temperature indicator connected to thermocouples built in to the windings. Incoming and outgoing air temperatures were taken by thermometer as well as the temperature of core iron. Dial thermometers on the bearings were checked by thermocouples built into the bearing babbitt. 15,000 cubic feet of cooling air per minute is required for this unit.

At the conclusion of the heat run the hot resistance of the field was obtained by voltmeter-ammeter and bridge methods. This reading, in comparison with a cold resistance taken later, gave the average temperature attained by the field winding.

The "V" curve (Fig. 1,) was next plotted by varying the field current and noting the stator amperes resulting. At first sight this would appear very simple but it must be remembered that at all times the bus voltage must be maintained and any change in the total reactive kv-a. produces a change in voltage. For this reason as field was reduced on the condenser under test it was increased on the other machine bringing the latter up gradually from lagging to leading reactive kv-a. Even with full leading reactive kv-a. on the older machine and with the light load conditions at the time at Oshawa it was not possible to reduce the field on the new machine far enough to obtain operation at lagging power factor without connecting in the second line to Oshawa. When this was done and still with the older machine "boosting" at 1,500 kv-a. it was possible to take the 5,000 kv-a. condenser down to its rated capacity lagging without shifting the voltage from rated value.

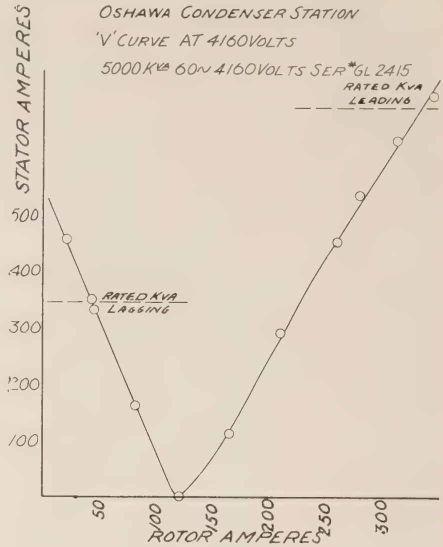


Fig. 1

When this work was completed the machine was shut down and the phases isolated for high potential test. Ten thousand volts was applied for one minute between each phase and ground and between phases of the stator winding. Fifteen hundred volts was applied to the rotor winding and the exciter.

The following day cold resistance measurements were made on the field and the temperature of the field windings observed.

The observations made during the taking of the "V" curve confirm the expected results determined by calculations before this machine was ordered. This condenser gives the operator at Oshawa full control of voltage on the bus even if one of the two transmission circuits is disconnected and permits advantageous adjustment of voltages at the generating stations on the Central Ontario System without affecting voltage conditions at Oshawa. Further advantages in capacity of transmission circuits will accrue as the load in Oshawa increases.

Early Types of Electrical Fittings

By W. P. Dobson, Chief Testing Engineer, H.E.P.C. of Ont.

THE electrical art is of such recent origin and its progress has been so swift, that it is not often that we take time to survey its history and to consider the radical changes in practice and in equipment which have resulted from this progress. It is a surprising fact that some of the earlier designs of equipment, have survived in their essential details and are still used. Other fittings however have undergone a radical change and it is often difficult when one of these relics of the past appears to recognize just what its use was in the early days.

In the rush of progress old installations are being continually replaced by new, and very few people appear to be sufficiently interested in the history of the art to preserve any relics of past practice in the form of fittings and equipment.

It was therefore with great pleasure that the writer received an offer of several items of such equipment from Mr. Frank P. Vaughan, Electrical Engineer of St. John, N.B., who is prominent in the electrical industry of the Maritime Provinces, and has recently taken an active part in the work of the Canadian Electrical Code.

Mr. Vaughan has furnished the following information regarding the fittings which are illustrated in this article.

The switch illustrated in fig. 1, is composed of wooden blades with laminated sheets fastened to the ends and V-shaped contacts. The method of operation of the switch will be clear from the photograph. The handle (shown at the top) has been broken off. This switch was installed about 1894 on a 52-volt service in what was known as the New Victoria Hotel Building, Prince William St, St. John. The building was remodelled about 16 years ago, when the switch was obtained.

Fig. 1—Switch with wooden blades.

In fig. 2, is illustrated a wooden horseshoe canopy cutout; a fuse wire is held under the binding screws and separated from the wood by a sheet of mica. This was removed from a residence in St. John in September, 1928. In Mr. Vaughan's opinion it probably dates back to the 1894 period.

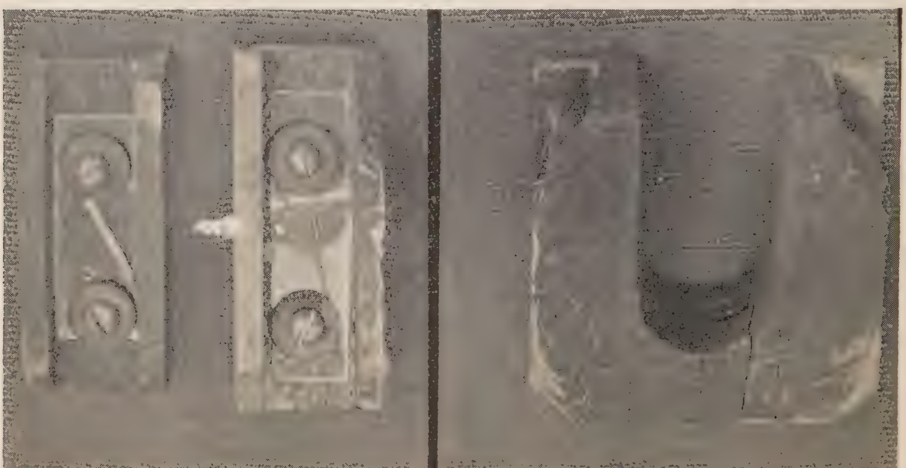


Fig. 2—A wooden horseshoe canopy cut out.

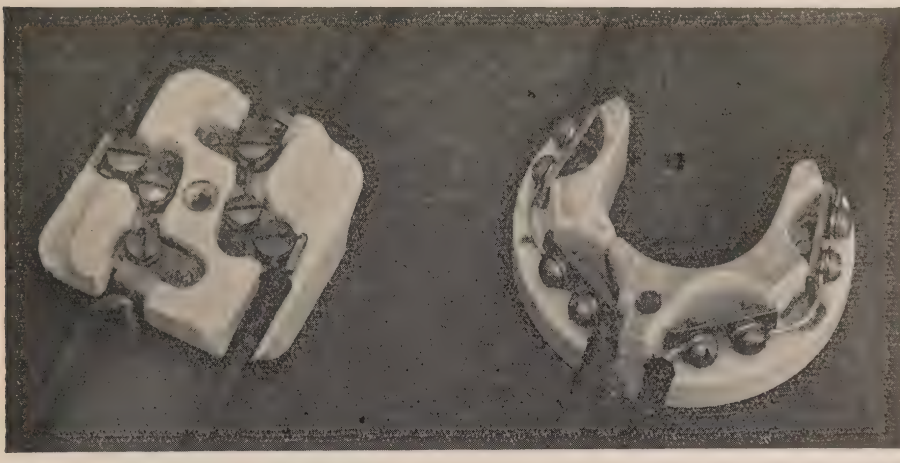


Fig. 3—A Porcelain horseshoe cutout and 15 amp. branch-block.

In (fig. 3,) is illustrated a porcelain horseshoe cutout and 15 amp. branch block. This was taken from the same residence and is evidently of a later type than the previous fitting.

The wooden cleats and vulcanite tubing illustrated in fig. 4, complete this interesting record furnished by Mr. Vaughan. The vulcanite tubing was used before the porcelain tubes

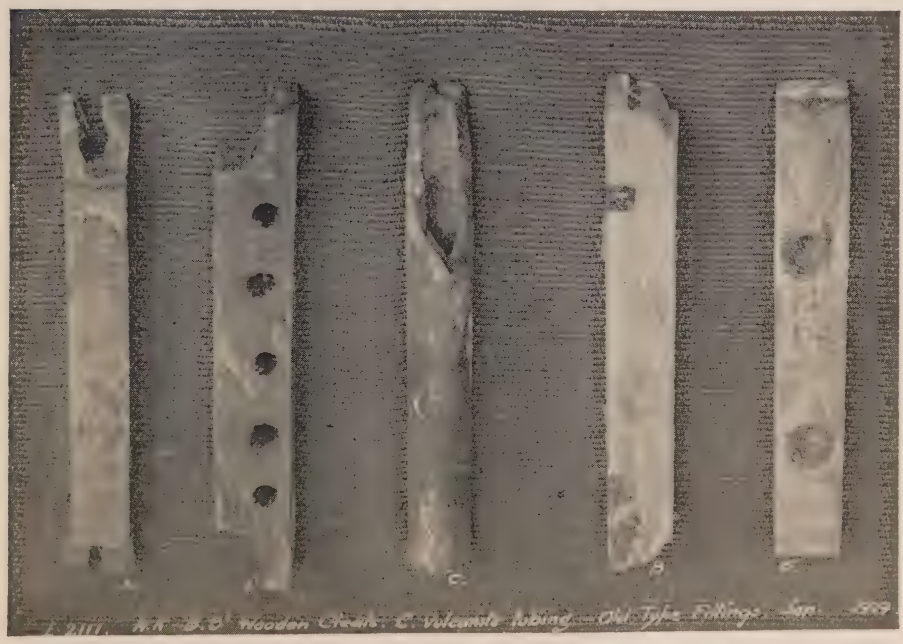


Fig 4—Wooden cleats and vulcanite tubing.

displaced it. It was sold in lengths and cut off on the job to the length required.

These samples are at the laboratory where they will form the nucleus of a historical collection of electrical fittings. We shall be glad to receive samples at any time to add to our collection.

Hydro-Electric Installations

By James McLelland, Civil Engineer, London

(Abstract of paper presented at the Engineering Conference of the Institution of Civil Engineers)

IN 1920 the total water-power developed and in course of development throughout the world was approximately 23,000,000 h.p. It is now approximately 35,000,000 h.p., and is increasing at the rate of 1,500,000 h.p., a year. The capital expenditure incurred on constructional work can scarcely be less than £700,000,000. The principal water-power countries, with the approximate horsepower developed, are the United States (12,000,000 h.p.), Canada (5,000,000 h.p.), Italy (2,500,000 h.p.), Norway, Switzerland, France (2,000,000 h.p. each), and Sweden (1,500,000 h.p.). The hydro-electric plant capacity now operating in Great Britain is less than 100,000 h.p. The estimated consumption of electricity in Great Britain in 1940 will require a plant capacity of about 13,000,000 h.p. The greater part of this plant will, however, of necessity be steam-plant. In Canada during last year (1927) hydro-electric plant aggregating 221,655 h.p., was completed, and during the first half of this year (1928) further plant aggregating 378,000 h.p., will be put into service.

The size of hydro-electric installations has grown immensely owing principally to the greater economy in large electrical units and the growing demand for large bulk supplies in the electro-chemical industries. The Isle Maligne installation on the Saguenay River, Quebec, will have an ultimate capacity of 540,000 h.p. The Queenston-Chippawa plant (completed in 1925), on the Canadian side of the Niagara River, utilizing nearly twice the actual head at the Niagara Falls, has a capacity of 550,000 h.p. The Bridge River project in British Columbia will have a capacity of 600,000 h.p., to 700,000 h.p., and the projected development at Chute-á-Caron on the Saguenay will produce 800,000 h.p.

A development now in progress in California will operate under a head of 2,561 feet. The highest head of water so far developed in one stage is 5,360 feet at Lake Fully in Switzerland, the highest head in this country being one of 1,150 feet developed at Cwm Dyli at the foot of the Snowdon Range. The development of very high heads has been facilitated by improvements in the design and manufacture of steel pipes and cast-steel special pipes. Improvements in plant have similarly contributed to the economic development of low heads, which is now possible owing to

the use of highly efficient turbines of the propeller-runner type, operating at a relatively high speed.

More attention is being directed to questions affecting the future of installations and the total amount of power that may ultimately be made available at power stations—for example, in the case of high-head developments, by the heightening of dams, by the tapping of additional drainage areas by leats or tunnels, and by the installation of pumping plant for pumping into high-level reservoirs water available at lower levels. Generally, a broader outlook is being taken of future possibilities and requirements, and in the case of installations capable of extension, the importance is realized of adopting, in the first instance, such layouts and types of structures, and of executing such preliminary work, as will enable the extensions to be carried out, when required, as readily and economically as possible. The use of syphons and automatic gates for the close regulation of the water-level of storage ponds and reservoirs is increasing. In this connection it may be mentioned that in the recently completed Guernsey irrigation and power dam in Wyoming, two automatic spillway gates each 64 feet long and having a maximum combined capacity of 30,000 cub. ft. per second have been installed.

In the case of tunnels and open conduits, the efficacy of concrete linings in the direction of reducing friction losses and increasing carrying capacity has received fuller recognition and in the construction of such linings more attention is being paid to the importance of obtaining smooth surfaces. An interesting example of the use of a concrete lined tunnel is provided by the Lochaber installation now approaching completion. This tunnel from Loch Treig, of horseshoe sect on, 15 ft. to 16 ft. in diameter and designed for a speed of water up to 10 m.p.h. will carry the water for 15 miles through the northern slopes of Ben Nevis to a point about ¾ mile above the power station at Fort William. An interesting problem will be presented in the final connection of this tunnel with Loch Treig, at a depth of 100 ft. below the water surface. A similar tunnel, though only 3-¾ miles in length, has been used in the Ponale hydro-electric installation of 100,000 h.p., situated at the northern end of Lake Garda, Italy. The intake of the tunnel is 70 ft. below the mean level of Lake Leydo, about 1,100 ft. above the power house. The water at this depth at the intake end was successfully let into the tunnel by the explosion of a series of charges in March, 1928. In this connection it is noteworthy that concrete-lined tunnels and concrete pipes are being exposed without serious damage to increasingly high pressures and velocities of water. Possibly the highest velocity concrete has yet been successfully subjected to is in the diversion tunnel of the new Arapuni Dam in New Zealand, where with the gate partly opened and at full head it is estimated the velocity of the water must have approached 60 m.p.h.

Sufficient success has been obtained in the solution of the ice problem to justify consideration of hydro-electric development as practicable in the

coldest climates. Among means employed to ensure continuous operation are the enclosing of penstock gates and screens in heated gate houses, the lagging and electrical heating of exposed regulating gates, the covering of penstocks and pipe lines, and the provision of special types of intakes. In some of the installations in cold climates, where the storage pond is very rapidly frozen at the approach of winter, deep canals and forebays are provided capable of conducting the required quantity of water beneath the overlying ice.

In cold climates, where pine and fir are usually cheap and easily procurable, the construction of wood-stave pipe lines, which have the advantage of requiring little or no protection against frost, has attained a high degree of success. In the 98,000 h.p., development of the Newfoundland Power & Paper Co., at Grand Lake, Newfoundland, wood-stave pipes were used for the upper or low-pressure portion of the penstocks, the diameter of the pipes being 9 ft. 6 in., and the aggregate length for the seven penstocks 15,500 ft.

Certain types of dams, for example, hollow dams of the multiple arch and Ambursen types, and embankments placed by the hydraulic and semi-hydraulic fill processes are increasing in favor. In the development of the Newfoundland Power & Paper Co., an Ambursen dam 1,050 ft. long and 80 ft. high was completed in nine working months. In many sites, however, the Ambursen dam is not suitable, and the largest dams continue to be generally of the gravity or arch type. In the North Wales Power Co.'s development at Maentwrog, which has just been completed, and includes an arch dam 124 ft. high and three smaller gravity dams, an interesting feature is the extent to which the grouting process was made use of in sealing the rock foundations below the level of the cut-off trenches, the total amount of cement so used being approximately 700 tons. A considerable increase has taken place in the height of dams. Until recently the highest was the Camarasa dam, near Barcelona, 319 ft. high, but the Exchequer Dam in California, 330 ft. high, now exceeds this, and the now practically completed Pacoima Dam (mainly for flood control) will have a height of 385 ft. The Punjab Government is at present considering a large development on the Sutlej River which would involve a dam of 380 ft. in height. In one of the many proposals put forward for the flood control of the Co'orado River, which conflicting state interests have so far thwarted, a dam at Boulder Canyon of the almost incredible height of 600 ft., is apparently proposed, to cost more than £10,000,000.

The whole question of dam design is receiving considerable attention, accentuated by recent disasters such as the Gleno Dam in Italy, 164 ft. high, partly massive masonry and partly multiple arch, which collapsed seven weeks after completion in December, 1923; the Eigiau concrete dam, and the earthen Coety dam with a concrete core, both at Dolgarrog in North Wales, which failed in November, 1925; and the St. Francis Dam in California, a gravity dam 208 ft. high and 668 ft. long,

completed less than two years ago, which failed with an estimated loss of 300 lives and of £3,000,000. In the majority of cases, it is safe to say that bad foundations, or over-topping due to inadequate spillway capacity, have been the main causes of failures. The North Wales disaster exemplifies the increased risks where dams are constructed one above the other in the same valley. Public anxiety in this country has led to a demand for compulsory inspection. The problem is also being tackled on the technical side in the valuable investigations which are now being carried out into arch dam construction on the Stevenson Creek test dam in California, which is 60 ft. high and 140 ft. long. Complete and continuous measurements of the various strains and deflections have been made, during both construction and filling. The whole data collected will undoubtedly be interesting and valuable.

—*Engineering*

HYDRO NEWS ITEMS

Central Ontario System

The Central Ontario and Trent Systems have experienced a particularly good year during 1928 and all the cost towns, with one exception have received substantial credits on their power bills.

* * * *

The municipalities of Orono and Newcastle are now supplied with three-phase power instead of a single phase supply which has existed for a number of years.

* * * *

The Belleville rural district is being widely extended and contracts have now been signed for approximately twenty miles of additional line.

* * * *

Georgian Bay System

In the early summer of 1928, a substation of 100 kv-a. capacity was erected at Fennell's Corners in the Township of West Gwillimbury on the 22,000 volt line serving the Village of Bradford, and from this station some 13 miles of rural line was constructed to serve consumers in the hamlets of Gilford, Churchill, Lefroy, and Belle Ewart, and summer cottagers along the west shore of Lake Simcoe, particularly in the subdivisions known as DeGrassi Point, Belle Ewart, Belle Air Beaches, Tent City and Big Cedar Point.

Summer residents in this district are enthusiastic about Hydro service, and sufficient contracts have already been signed this winter to permit of an extension as early in the Spring as the construction can be carried out, of 5½ miles of additional lines along the lake shore from Big Cedar Point to Sandy Cove.

It is expected that the demand for power in this area will approach 100 h.p., this summer.

* * * *

As the result of a movement originating with the farmers between Wingham and Wroxeter, and a canvass carried on by a Committee of farmers, sufficient applications were secured to extend the line fourteen miles from Wingham through Bluevale to Wroxeter and north.

As soon as the Committee was able to report success of their endeavor, the Village of Wroxeter made application for legislation to disband and then carried on a canvass within the Village securing sufficient contracts to warrant including this area with the other, and to create a rural power district which is now known as "Wroxeter," construction being started late in the Fall, using farmers' help when it became available, as much as possible, which has resulted in getting the main line constructed throughout. Secondary construction is almost complete, and it is expected that the line will be made alive the end of this month.

* * * *

Construction is well under way on a 38,000 volt line from Kilworthy

about 6 miles south of Gravenhurst to Wasdells Falls which will tie in the Muskoka and Wasdells plants. The conductor is being strung at the present time and the line will be ready for service about the middle of February.

* * * *

Work was completed on a rural line extension out of Uxbridge on January 5, 1929. The line is approximately twelve miles in length and serves the hamlet of Goodwood, as well as the intervening farms and the area immediately adjacent to Uxbridge known as Quaker Hill with a total of 61 consumers.

* * * *

Approximately eight miles of line was added to the Mariposa Rural Power District during the late Fall, with service to 29 consumers, the majority of whom are farmers. A portion of the original system was also converted to 4,000 volts in order to improve balance and voltage regulation.

* * * *

Approximately 1½ miles of rural line has been completed in Barrie Rural Power District serving the Hamlet of Cundles immediately north of Barrie, and a few farms along the new Provincial highway. The line was placed in service at the end of October.

* * * *

Niagara System

The Rural and Inspection Offices at St. Thomas have been moved from the Dowler Building to more spacious quarters at 223 Talbot Street. It is the intention of the Commission to do the billing of the St. Thomas and the Dutton Rural Power Districts from the field office in future.

* * * *

The Municipality of Petrolia has formed a Public Utilities Commission, and the Hydro and Waterworks systems have been operated by this new Commission since the first of the year.

* * * *

Due to an increase of approximately 300 per cent in load over a period of two years at the Police Village of Grand Bend, in the Exeter R.P.D., extensive changes in secondary equipment have been necessitated, the equipment to be in service for the coming summer.

* * * *

The new Scarboro Distributing Station is nearly completed, and it is expected to be put into service about February 9. It will supply power to the Scarboro Township Hydro-Electric System, Village of Agincourt and Scarboro Rural Power District.

* * * *

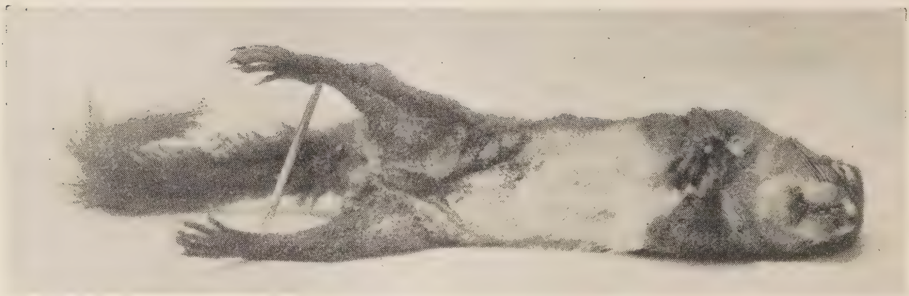
The number of consumers in Stamford Rural Power District has been materially increased by the addition of sixty or more services which until very recently were supplied by an industrial plant near Thorold. The total consumers in Stamford R.P.D. are increased 25 per cent by the change.

* * * *

Contracts have been received on a rural primary extension in Waterford Rural Power District, north from Waterford to Wilsonville and east to Boston. It is expected that construction will commence in the spring, the extension being about 7 miles and will serve approximately 50 consumers.

St. Lawrence System

The Village of Athens, County of Leeds, was first given service on Dec. 21, 1928, and became an additional Hydro municipality of the St. Lawrence System. The distribution system was built by the construction dept., of the H.E.P.C. of Ont. Power is supplied over an 8,000 volt, 3-phase line from a step-down station near Brockville. This station will also serve the rural district between Brockville and Athens and surrounding district. A considerable increase in the number of rural users of electric service has recently taken place.



This is a picture of a red squirrel that caused an interruption to the Orillia 22,000 volt transmission line early one morning near the first of the year. The path of the current was from the left front leg and through the body to the hind legs. Although this line has been interrupted a number of times in a similar manner, this is the first time that the squirrel was not burned to a cinder.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE

BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Industrial Electric Heating

By J. S. Keenan, Industrial Heating Specialist, Canadian Electric Co., Limited, Toronto.

(Read before Association of Municipal Electrical Utilities at Toronto, January 23, 1929.)

MUCH has been said and written about the possibilities of the industrial heating load and some claim that in the not distant future it will equal the combined motor and lighting load. Many of the large central station companies have been very successful in the development of industrial electric heating. The Detroit Edison Company has over 50,000 kw. in electric heating apparatus connected to its lines. The Toronto Hydro-Electric System has made very good progress in developing this class of business. The General Electric Co., has over 40,000 kw. of electric heating apparatus installed in its various plants consuming more than 80,000,000 kw-hr. per year. From the power companies point of view the industrial heating load, with the exception of arc furnaces and spot welders, approaches the ideal. The resistor type of furnaces and ovens find their greatest advantage where operations are carried on day and night, month after month. Power factor is unity and load factor is very high.

It is appreciated that each central station company must be governed in its method of handling its industrial heating business by the number and character of its potential customers. The larger companies follow the practice of selecting one or more power sales engineers to handle heating propositions exclusively. The men must be trained and experienced in the selection and application of equipment. The small systems cannot justify the services of a specialist and the work must be taken care of by the

CONTENTS

Vol. XVI **No. 2**

February, 1929

	Page
Industrial Electric Heating - -	29
Investigation of Domestic Demand	36
Domestic Appliance Load Factor -	48
A.M.E.U. Reports - - - -	56

regular staff. The writer is fairly well acquainted with conditions influencing the sale of electricity for industrial heat in Ontario, and I shall attempt to make to-day a few suggestions which I hope will be of value to the smaller systems. There are so many and varied applications that it is not desirable at this time to attempt to deal with any of them in detail. It is impossible and unnecessary for the managers and superintendents of the Ontario municipal electric systems to keep posted on the engineering features of industrial heating. They can however, accomplish much by discussing the subject in a general way with their customers at intervals and calling in a representative of a reputable manufacturer when they think the prospect is sufficiently well interested. When the consumer shows a disposition to proceed with the installation of electric heating apparatus, the power company should co-operate with him in providing circuits to handle the additional load. Many consumers who would like to install electric furnaces or ovens are discouraged from doing so by the fact that their transformers or feeder circuits are loaded and they do not feel like making the expenditure necessary for extra supply equipment. Proper engineering advice often overcomes the difficulty and permits the installation of the electric heating apparatus.

Perhaps a brief description of a few of the installations made in Canada during the last few years will be of interest. Advantage may be taken of variations in the consumers power demand to operate furnaces or ovens fairly continuously with little or no increase in his maximum demand.

One Canadian wire manufacturer has a machine which draws an intermittent load of 150 kw. The machine is operated at full capacity for 10 minutes and then it is shut off for 10 minutes. An electric furnace rated 150 kw. was installed and electrically interlocked through an automatic control device so that it comes on the line when the mechanical load drops and vice versa. The plant's electric demand is not increased by the furnace, the load curve is made practically straight and enough heat is obtained to anneal the required amount of wire. The energy used by the furnace is, therefore, available at the minimum rate and the cost of annealing wiring electrically is approximately 25 per cent. of the cost of doing the same work in an oil fired furnace which has been abandoned.

Another Canadian industrial plant has a maximum demand of about 2,000 kw. Approximately 600 kw. of the total demand is required by large compressors which operate intermittently one or two days a week. Electric furnaces rated 600 kw. for annealing metal were installed. An

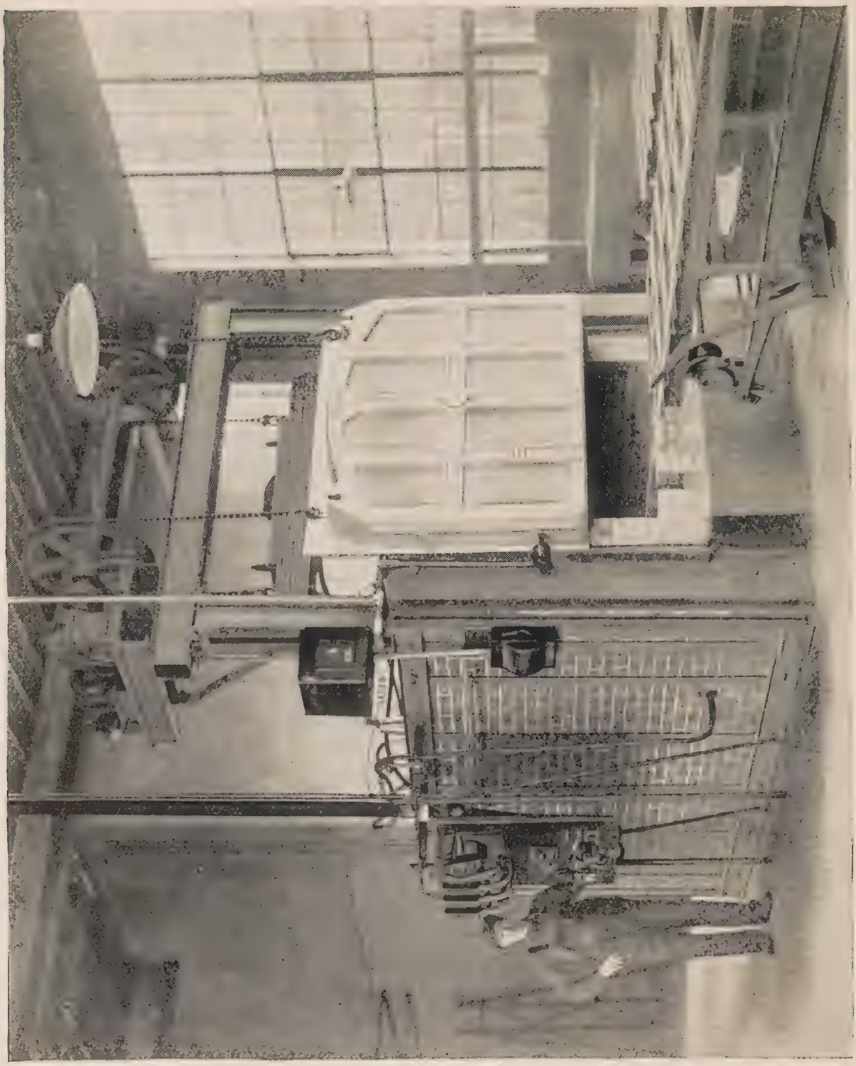
automatic load control equipment was installed which prevents the furnaces from increasing the plant's maximum demand. The desired result is accomplished by a contact making demand meter, which operates to disconnect the furnaces when the allowable peak load has been reached. The furnaces are automatically reconnected when the plant demand has decreased so that the furnaces may again be carried. Several years actual operation have shown a valuable increase in plant load factor and the cost of annealing the metal is approximately one-half of the cost of doing it with fuel oil.

A Canadian manufacturer of storage batteries melts in electric furnaces all the lead of which the plates are cast. The cost of electricity is only a fraction of the cost of operating gas fired furnaces which have been replaced. The saving in fuel in a period of seven months is sufficient to cover the first cost of the electric furnaces. In addition, the automatic, temperature control produces better storage batteries and the working conditions in the room are much improved.

The Canadian railroads are swinging over to electric furnaces exclusively for hardening and tempering steel, for expanding locomotive and car tires, for annealing and case hardening mechanical parts and similar operations. One of the railroads has found that locomotive springs heat treated in electric furnaces last much longer in service than those treated in fuel fired furnaces. The cost of removing broken springs from the locomotives and replacing them with new ones is many times the cost of electricity for heat treatment. Electric heat would be justified for this particular work if it cost many times as much as fuel heat.

On the contrary, electric heat at Ontario rates is on the average less expensive than gas or fuel oil heat for industrial operations. On a production job steel is heat treated at 1,600 deg. F. with a consumption of 200 kw-hr. per ton, worth $2.00 at one cent per kw-hr. In the average oil fired Box furnace the oil consumption is about 40 gallons per ton worth $4.00 at 10 cents per gallon. This figure of $4.00 is to be compared with a cost of $2.00 for electricity for doing the same work.

The melting of stereotype metal in newspaper plants is a good application of electric heat. The same metal is melted down each day and from it are cast the semi cylindrical plates which are placed on the printing press cylinders. The maximum demand for the newspaper plant is established by the motor which drives the printing press. The plates are all cast before the press is started and the furnace is automatically cut off by a control device when the press motor is energized. The electricity for melting the metal is, therefore, obtained at the energy rate without service charge, with the result that the metal is melted electrically at less cost than it can be done by coal. One Toronto newspaper has installed electric heating equipment which melts 50 tons of metal per day with an annual consumption of nearly a million kilowatt hours. A large percentage of the Ontario newspapers have been equipped during the past two years with electric stereotype



Electric Furnace for fusing vitreous enamel, rated 140 kw.

melting equipment. In the smallest daily newspapers the yearly consumption for this duty alone is over 75,000 kw-hr.

The automobile industry, being young and unhampered by tradition, has been the most progressive in adopting electricity for its many and varied heating operations. The United States automobile companies generally have enough production to justify putting in equipment for the manufacture in their own plants of nearly all the required parts. The Canadian automobile companies on the contrary buy parts, such as gears, springs, axles and bumpers, from concerns who manufacture such parts for a number of automobile companies. One such concern, the Central Spring Co., at Oshawa, has an electrical furnace rated 400 kw. which

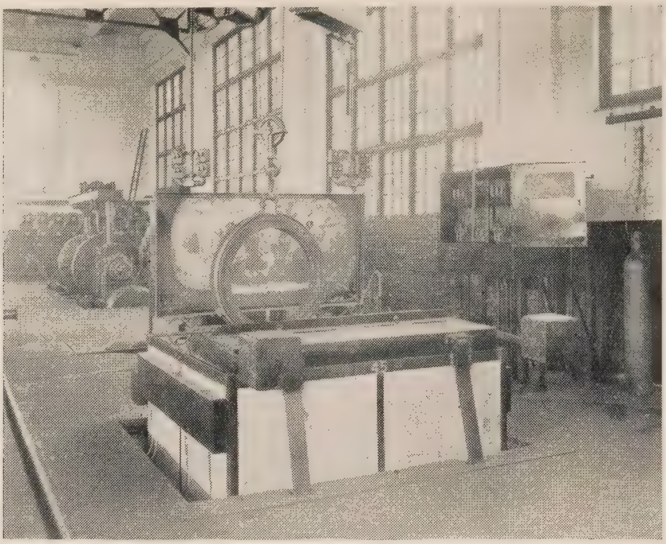
tempers more than 2 tons of automobile springs per hour. The cost of electricity is less than the cost of fuel oil would be. The temperature control and quality of product is better and maintenance cost on the furnace itself is less. Two concerns which manufacture gears, each have a number of electric furnaces installed at the present time and each is installing more electric furnaces. Nearly all the Canadian automobile plants installed originally electric ovens for baking enamel on fenders and similar parts. Until very recent years the plants operated at high capacity for a few months in the spring, with little or no production throughout the balance of the year. The ovens naturally established a high demand on which a monthly service charge was required. On account of this service charge some of the ovens were changed to oil firing. Automobile making is now carried on more regularly through the year, and we can expect to see these ovens changed back to electric heat.

One Canadian industrial plant uses electric furnaces of total rating 1,600 kw. for melting and annealing metal. These furnaces operate continuously 24 hours per day and consume five and one-half million kilowatt hours annually. A Canadian manufacturer of enamelled ware began using electric furnaces for fusing enamel several years ago. They have constantly been adding furnaces and in a few months they will have a total rating of 1,000 kw. Their yearly consumption of energy will then be about three and one-half million kilowatt hours.

The interest shown in electric heat by Canadian industrial plants, particularly during the last two years, has been very gratifying. Nearly all the concerns equipped to apply porcelain enamel use electric furnaces. The majority of them use electric furnaces exclusively. Nearly all the recent installations of ovens for applying black enamel to stove parts, electric fittings and automobile parts are electrically heated. Electrically heated ovens are also largely being used for baking electrical insulation, drying paint and many other purposes.

One or two large power distributing organizations in Ontario have during the last few years made energetic efforts to sell electric heat with gratifying results. Apart from these few organizations the work of promoting and selling has been left largely to the equipment manufacturers. One Canadian concern has during the past year manufactured industrial heating equipment, having a total connected load amounting to 9,000 kw. It is estimated that this equipment will consume annually more than twenty million kilowatt hours. Assuming an average rate of one cent per kw-hr., one equipment manufacturer has within a year added an amount estimated at $200,000.00 to the annual income of the central stations of the country.

There are a number of applications from which a few months' revenue equalled the first cost of the equipment. Naturally it is more to the advantage of the power distributor than to the equipment manufacturer to promote such installations. The manufacturers naturally pursue most energetically the propositions requiring the more valuable equipment.



Tire expanding electric furnace used in Railway Shops

Among the applications of lesser value to the manufacturer but relatively high in current consumption may be listed the following:

Heating plating solutions and washing solutions, usually in open tanks.

Heating glue, pitch, babbitt, solder, soft metal and various compounds.

Heating small outlying buildings, valve houses, crane cabs.

Heating small quantities of water and generating small quantities of steam for process work.

Many plants require small quantities of steam for process work. Steam is usually supplied from a large boiler, which boiler also heats the building during cold weather. Obviously it is an expensive proposition to keep a large boiler fired during the summer for the purpose of supplying a small quantity of steam. An electric boiler automatic in operation may be used to supply such process steam. From the average of a number of propositions of this class we have found an electric boiler justified at average Ontario rates, if the steam required is not greater than 7 boiler horse power, equivalent to the evaporation of 23 gallons of water per hour and a consumption of approximately 75 kw-hr. per hour. If the steam requirements are greater it is usually more economical to operate the fuel fired boiler.

It would appear that the water used for washing in the smaller city hotels could be advantageously heated electrically. A reasonably large storage tank well lagged and thermostatically controlled could be used. The current can be automatically turned off by a time switch at the time of the systems daily peak demand and automatically turned on again after the period of maximum demand has passed. Among many institutions heating washing water electrically are Osgoode Hall and the Canadian Bank of Commerce at Toronto.

In conclusion I will give a partial list of the desirable industrial heating applications in order of merit.

Firing vitreous enamel.

Annealing, hardening and tempering steel.

Melting and annealing non-ferrous metal.

Melting lead and other soft metals.

Baking black enamel and drying paint.

Baking foundry cores and moulds.

Baking bread in large ovens.

Hot process galvanizing.

Heating water and making steam.

Discussion

T. R. C. Flint, Toronto: We, of Toronto, have taken more than an interest in industrial heating and find it a rather desirable load. We find that the consumer does not realize the cost, so we work that out very carefully for him where there are quite a few installations. I think the reason why some installations were unsatisfactory was because the consumer at first did not know anything about the cost and, second, because he tried to make up the equipment himself. We try to guide him very carefully and have therefore prevented any installation going in that might later on prove of disadvantage to the consumer and give a black-eye to industrial heating.

One business in which we are very much interested at the present time is the cafeteria, and we also find a great field in the sandwich shops and places like that. We class them in the industrial field, and find that they are calling for a lot of that equipment at the present time.

Mr. E. V. Buchanan, London: Mr. Keenan brought up the point that in many factories the use of industrial heating was very advantageous because the customer could make use of electric heat during his off peak. Another point that should be stressed, is that the local Hydro Department could sell electric heating which is the off peak of the system. That could be done in the case of larger consumers, such as furnaces and that sort of thing, by means of a graphic meter, so that the system could tell the time that the consumer was on or off. But for smaller customers, the load may be so small that it would not justify the installation of a graphic meter and you could not give such a customer an off peak or a restricted hour rate. We have been looking into the feasibility in London of getting some sort of station control on such loads. The idea I have in mind is that by means of what is known as resonant control, as developed by the Westinghouse Company, or by means of a relay operated on a pilot circuit, such things as water-heaters in houses, restaurants or hotels, or any other type of industrial load could be made an entirely off peak business. It could be kept off the peak of the local business and could be kept off the Commission peak and so full use could be made of that off peak power which I have always been led to believe is the most desirable load the Hydro system could obtain.

Investigation of Domestic Demand

By H. D. Rothwell, Municipal Engineer, H.E.P.C. of Ont.

(Read before Association of Municipal Electrical Utilities at Toronto, January 24, 1929.)

AT the convention of this Association held on June 23rd, 1927, at Niagara Falls the writer read before the Association a paper entitled "Power Billing Based on Demand" in which was laid down some of the principles relating to the various items which entered into rate structures, and also reviewed some of the early history and findings of eminent investigators concerning the proper method by which the customers, whether they be commercial power, commercial lighting or domestic may be billed on a basis of equity with respect to one another. It must be kept in mind that the average citizen does not understand electric rates and finds them at times somewhat bewildering on account of the fact that he does not find their counterpart in any other business. It therefore should be the duty of the engineer, manager, or superintendent to constantly educate the public in the equity and justice of a rate which does take into consideration justice in the highest sense.

Various rate structures have from time to time appeared, only later to be discarded, due to the difference in the use which the consumer made of his service and the general equity entering into the charges. Early investigators have recognized that maximum demand must be given consideration, and approximations were made in the way of floor area, rooms, connected load, etc. These all have some relationship to the demand problem but as the uses of electricity are many and varied it is found that discrepancies may come in with respect to the relationship between the actual demands and the theoretical demands determined on the bases just mentioned.

In arriving at a rate to cover any type of service, the fundamental principles of service at cost to the individual customer must be the objective as well as the question as to whether an entire group contribute sufficient revenue to show a surplus at the end of the year.

The electric range has introduced a new rate problem, particularly in those municipalities which are highly industrialized and have not a great diversity of occupation, bringing about existing conditions which are quite unlike those of other municipalities whose citizens are engaged in an entirely different class of work. Since there is very little information available concerning the actual demand created by domestic consumers in general an investigation was made in a municipality with a population of approximately 30,000 people—a city highly industrialized and whose industries are mostly composed of the heavy and medium type. A study was made of the various classes of consumers and it was found that these

could be classified into three general groups,—

1. The ordinary lighting customer who comprises the great majority of the consumers served from the local utility and that type of consumer who does not make use of any of the large current consuming devices requiring excessive demand or consumption.

2. The lighting customer who uses an electric range but is not as yet equipped with many appliances.

3. The customer who has besides lighting, an electric range, water heater, electric fireplace and most of the appliances at present on the market.

In making these studies 75 single-phase maximum demand meters of the heat principle type were used, 25 of which were 15 ampere, 2-wire; 25, 25 ampere, 3-wire; and 25,50 ampere, 3-wire. These instruments recorded the ten minute integrated demand of the load taken by the consumers.

The meters in question were installed so as to commence operation on July 1st, and remained in service for a period of six months, readings being taken on the last day of each month of both kilowatt-hour consumption and maximum demand. In covering this period a record of Summer, Fall and Winter conditions

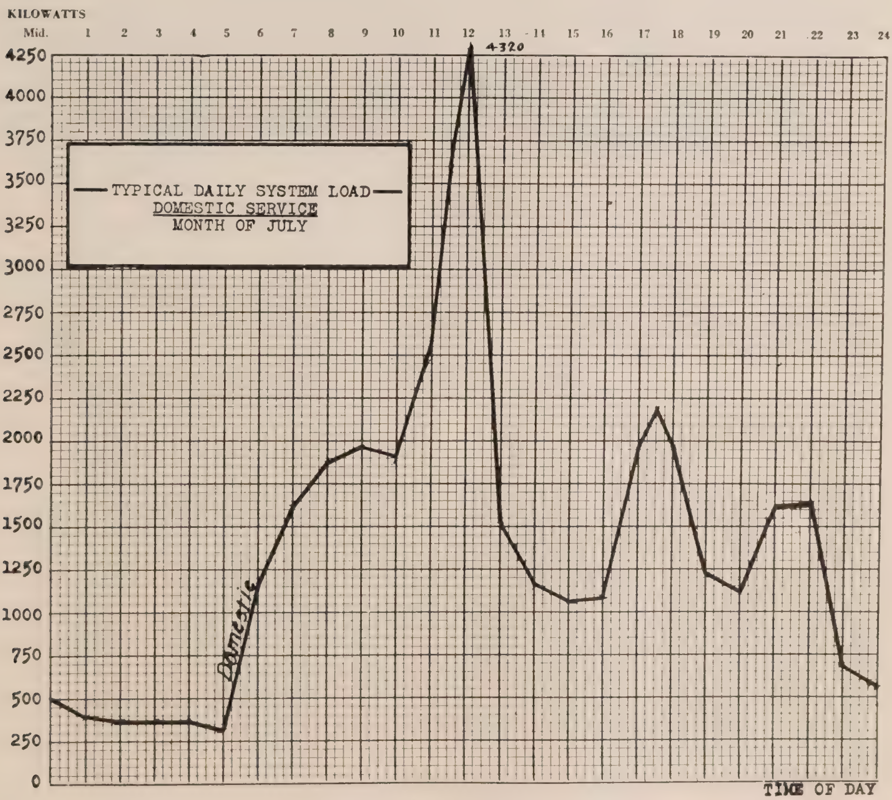


Fig. 1

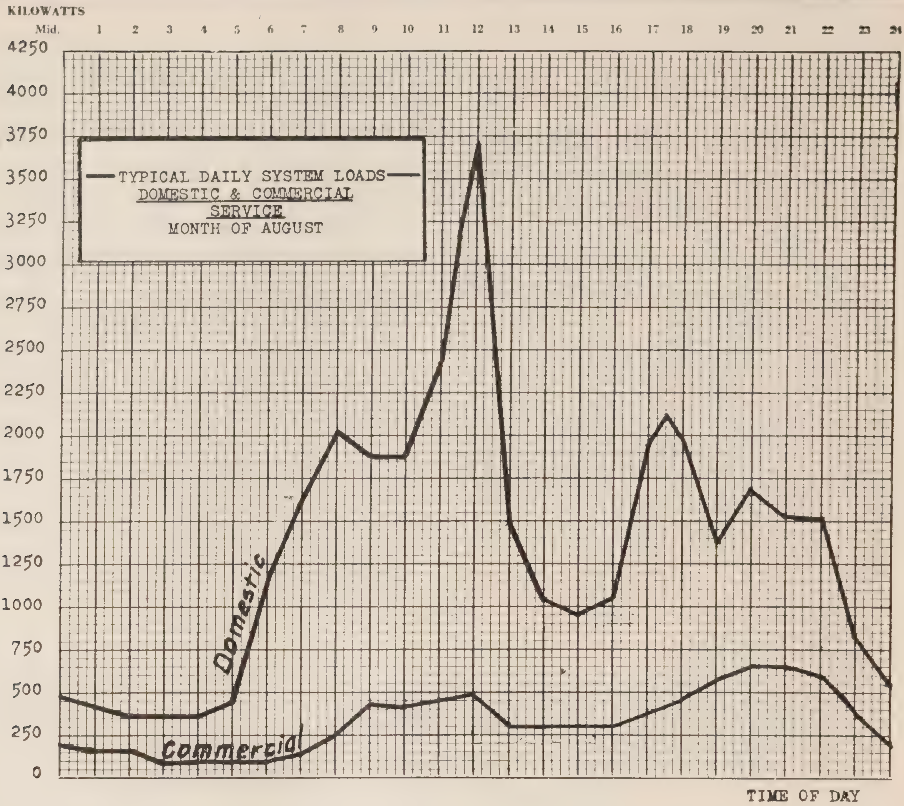


Fig. 2

was obtained as well as that period of the year when household furnaces and heating appliances come into general use, thus giving some idea at least as to the seasonable use of portable heating appliances.

The following tabulation of the results obtained from each group gives the minimum, the maximum, and the average connected loads; the minimum, the maximum and the average demands, as well as the kilowatt hour consumption. These cover the complete period of six months.

It will be observed that in Group No. I, which is an average condition of the ordinary lighting customer, the maximum demand is approximately 1,000 watts and the kilowatt-hour consumption will average approximately 68 kilowatt-hours throughout the year. In Group No. 2, the maximum demand is 5,580 watts with an average monthly consumption of 285 kilowatt-hours whereas in Group 3, the average monthly demand is 5,710 watts and the average monthly consumption, 440 kilowatt-hours. It should be especially noted that with the addition of appliances in the case of the large customer his maximum demand does not appreciably increase over the intermediate class whereas the kilowatt-hour consumption, or his

LIGHTING CONSUMERS: GROUP NO. 1

		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Connected load in watts	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed
Minimum	540	240	4	240	6	240	15	390	30	390	28	450	24
Maximum	4880	2250	169	2250	385	2260	141	2250	406	2250	234	2250	323
Average	2218	933	49	912	63	889	54	999	87	988	79	992	77

Average Monthly Demand—1,000 watts approximate.
" " Consumption—68 kilowatt-hours.
" " kilowatt-hours per kilowatt of demand—68.

LIGHTING CONSUMERS WITH ELECTRIC RANGE GROUP NO. 2

		JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
	Connected load in watts	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed
Minimum	4940	3500	85	3500	130	2300	130	2100	105	2000	150	1600	55
Maximum	144.50	7200	250	7500	520	7500	540	7000	560	7500	600	7500	485
Average	10862	5010	165	5780	319	5580	340	5550	327	5860	352	5750	308

Average Monthly Demand—5580 watts.
" " Consumption—285 kilowatt-hours
" " kilowatt-hours per kilowatt of demand—51.

individual load factor is very much greater. From the results obtained in the use of 75 demand meters as well as the kilowatt-hours recorded, these were applied to the total number of consumers in the city, as follows,—

TOTAL NUMBER OF CUSTOMERS

Group	No. 1	—	3902
"	No. 2	—	1755
"	No. 3	—	301
	Total	—	5958

Therefore:—

LIGHTING CONSUMERS WITH ELECTRIC RANGES AND OTHER APPLIANCES
GROUP NO. 3

	Connected load in watts	JULY		AUGUST		SEPTEMBER		OCTOBER		NOVEMBER		DECEMBER	
		Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed	Maximum demand in watts	Kw-hrs. consumed
Minimum	11085	2500	40	3200	80	3400	120	4000	140	3800	130	4600	110
Maximum	22508	8800	590	9400	840	10000	1090	9400	1200	10000	1290	10000	1280
Average	16080	5410	254	5800	385	6430	492	6040	417	5370	605	5880	488

Average Monthly Demand—5710 watts.
" " Consumption—440 kilowatt-hours.
" " kilowatt-hours per kilowatt of demand—77

	Summation of Individual Demands		Estimated Yearly Kw-hr.
Group No. 1:	3902 x 1 = 3902 kilowatts		3902 x 68 x 12 = 3,190,000
" " 2:	1755 x 5.58 = 9792	"	1755 x 285 x 12 = 6,000,000
" " 3:	301 x 5.71 = 1718	"	301 x 440 x 12 = 1,590,000
	15412	"	10,780,000

From the foregoing it will be seen that the summation of the individual demands on the total domestic service amounts to 15,412 kilowatts and the estimated kilowatt-hours consumed, based on the same line of reasoning, 10,780,000 kilowatt-hours. From the sub-station chart readings the amount of power required to supply 15,412 kilowatts of individual demands was 4,410 kilowatts: thus giving a diversity factor of 3.5. It is interesting to note that the actual kilowatt-hours consumed during the

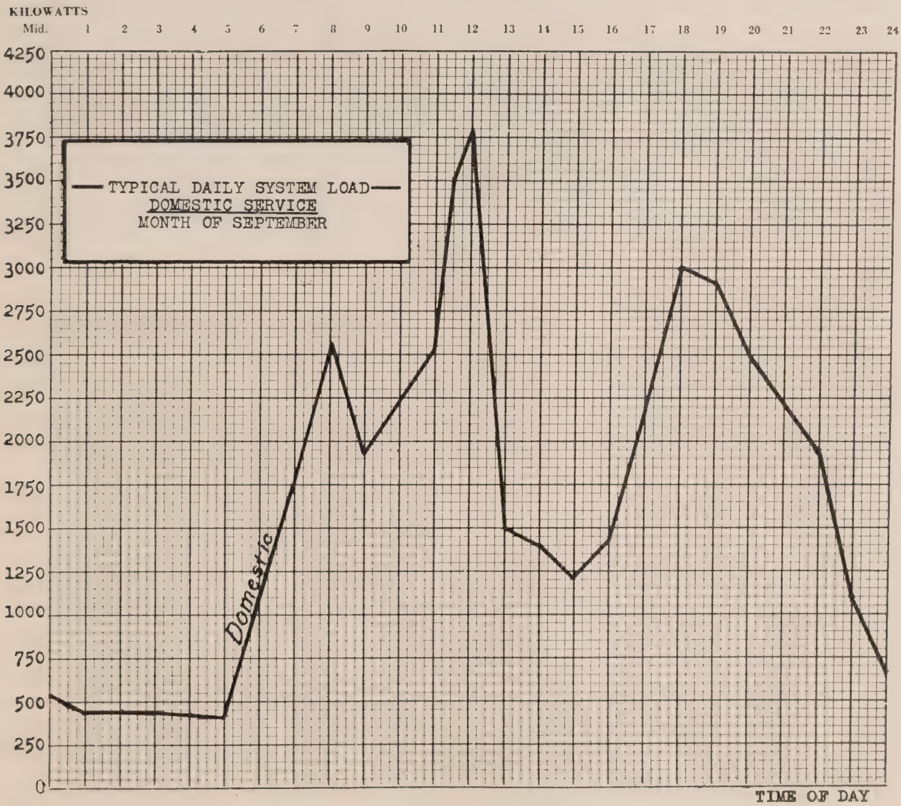


Fig. 3

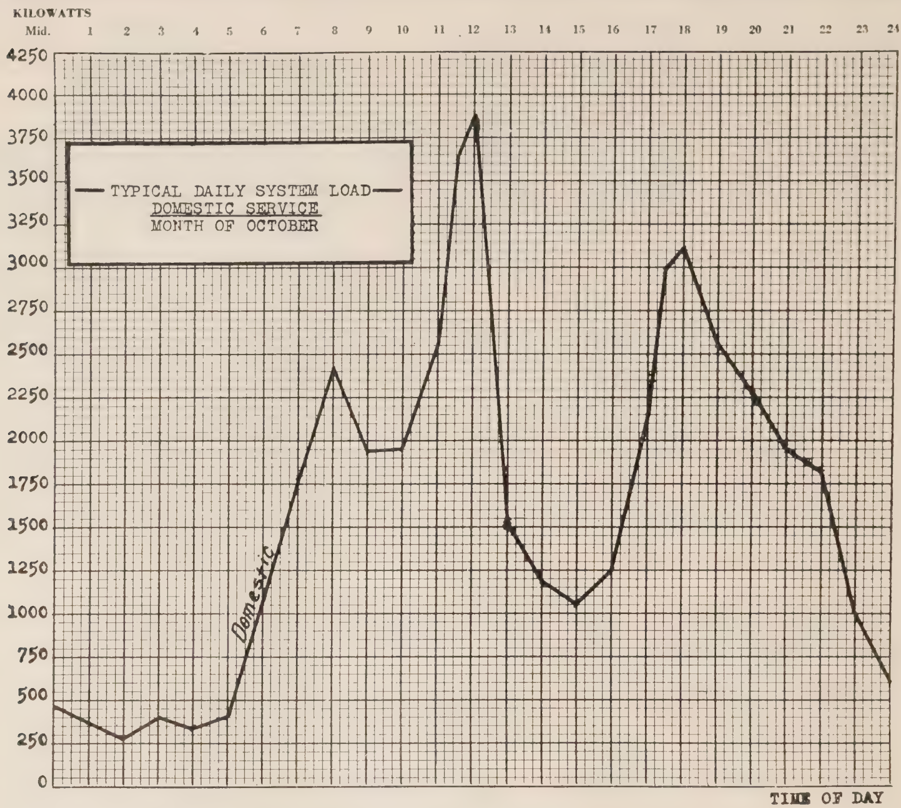


Fig. 4

year in question was 10,500,000, or in other words the selection of consumers as above illustrated proves that an average condition was reached by the installation of only 75 meters, as an error of only 2.66 per cent. existed between the actual kilowatt-hours and the calculated kilowatt-hours.

Figs. 1, 2, 3, 4, 5 and 6 show the load characteristics or typical 24-hour curves of the power required to supply domestic services in the months of July to December, inclusive. It will be noted that the condition at twelve o'clock noon shows that the electric range comes on creating a condition whereby a peak of nearly 2,000 kilowatts is established over and above any other peak during the day in the month of July. It will also be noted that the morning and evening cooking loads are small in comparison to those at the noon-hour. This condition exists throughout the entire year with the exception of certain characteristics during the fall months and the month of December. These changes are due to the overlap of the cooking and lighting loads in the evening, which peak very nearly approaches that at noon. The load factor is not good, especially in mid-summer. The result of this is self-evident to any one familiar with the supplying of this type of service. The commercial

load which has been indicated on the August and December charts does not materially change except in magnitude. The commercial peak remains nearly constant throughout the year and to a large extent comes on the noon-hour peak, therefore there is not a very great diversity between the domestic and the commercial lighting loads.

In order to further study the situation a review of the past ten years was made with the object of determining what changes in the capital or the system with respect to maximum demand, occurred during that period. This is illustrated to some extent in Fig. 7, which is a curve showing the proportions of power purchased and operating expenses to total expenses. Ten years ago the fixed expenses represented well over 60 per cent. of the total cost to the consumer. This has changed somewhat and at the present time represents less than 40 per cent. whereas the power purchased at present is in the neighborhood of 65 per cent. This condition has been brought about largely by the fact that the domestic load factor has been changing due to the range peak at mid-day. The result has been a gradually reduced diversity throughout the entire ten-year period. It is interesting to note that ten years ago

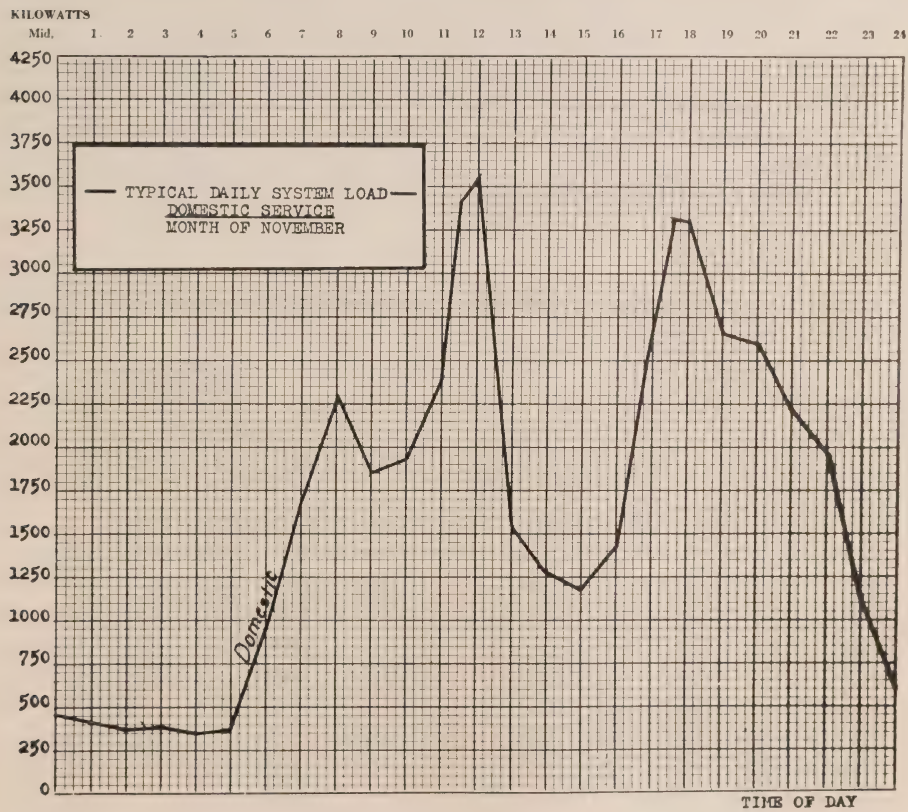


Fig. 5

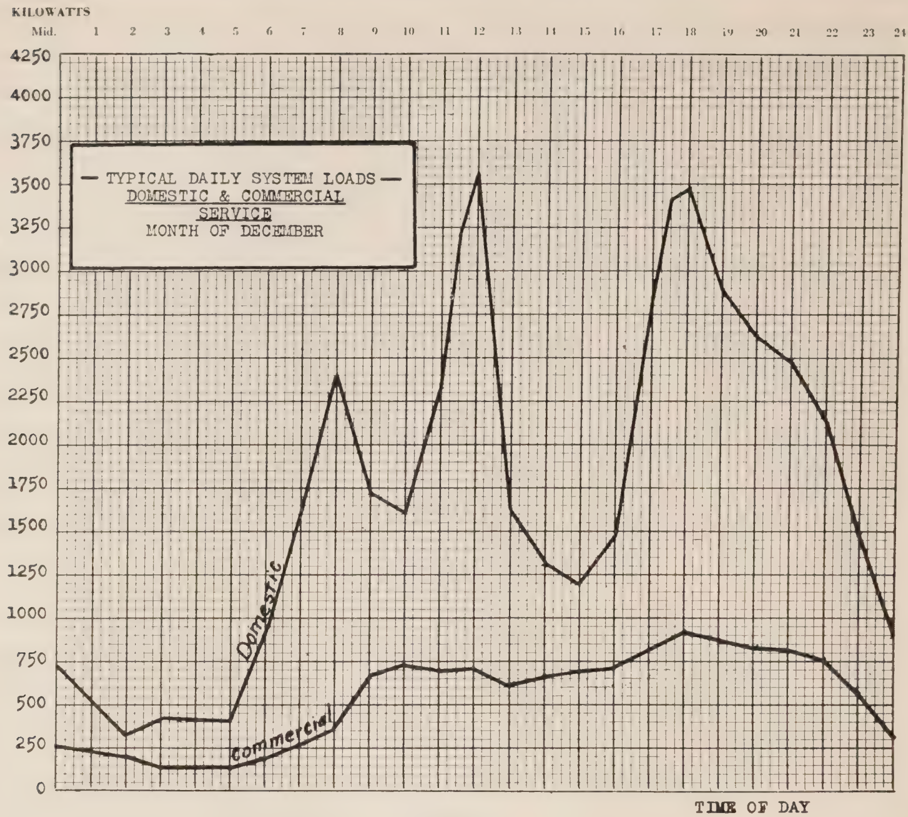


Fig. 6

the electric range was not an important factor, representing less than 150 installations whereas at the present time there are over 2,056 ranges in a total of 5,958 customers.

A further study was also made of various items entering into distribution capital to supply the lighting consumers and in Fig. 8 are shown curves in dollars per kilowatt of total domestic demand required to supply domestic service over a period of ten years.

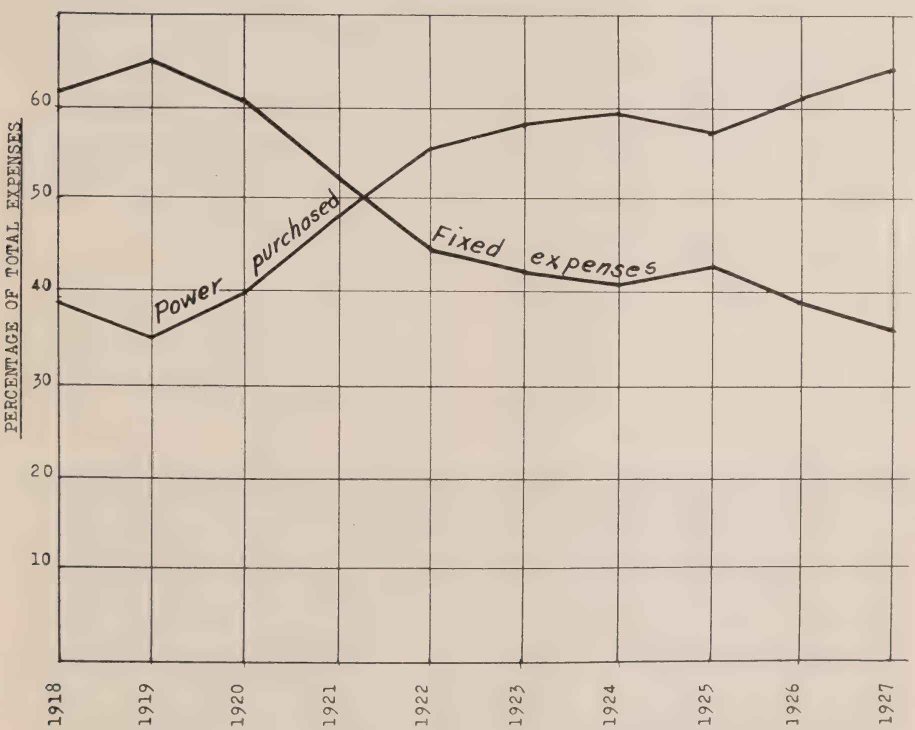
It will be noted that transformers and sub-station equipment costs remain almost constant whereas meters show a slight decline. Distribution system which includes copper and poles, shows a considerable reduction and the total assets are reduced approximately 40 per cent.

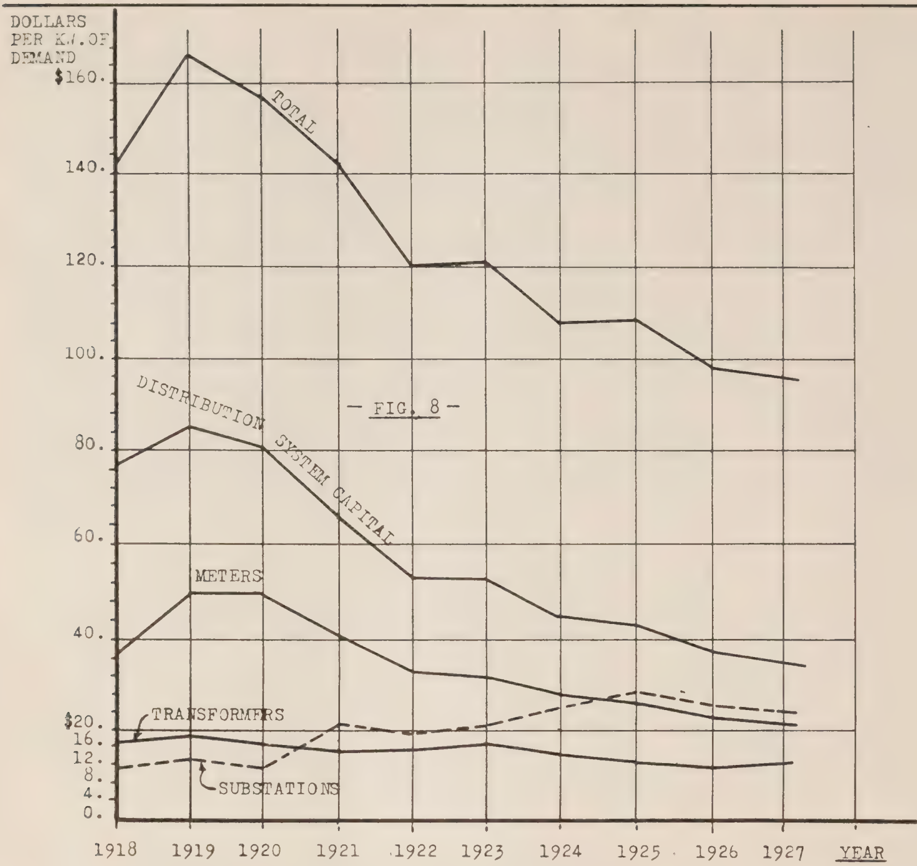
This goes to show that there is considerable stability in the cost of distributing power to lighting consumers with respect to the fixed charges and operating costs. It is to be expected that with advances in labor prices concerning operation that the fixed charges which would be chargeable to the demand over the past ten years would undoubtedly be a constant factor even paying additional labor costs for operation and maintenance of the distribution system. Furthermore, it is seen that the fixed expenses at the present time

are approximately 40 per cent. These fixed expenses should be chargeable entirely to the demand created by the various customers and in proportion to the demand created by the individual customer. In other words, Group One, should pay a service charge commensurate with the demand created, as also should Groups Two and Three, but whether the service charge per kilowatt of demand for Groups One, Two and Three should be the same, is a question. In determining the service charge it must be kept in mind that there are certain expenses which cannot rightfully be proportioned on a demand basis and must, therefore, be considered on a consumer basis. The following expenses might be considered on a customer basis, consumers' premises expenses, billing and collecting, promotion of business, undistributed expenses and general salaries, whereas sub-station operation, distribution system maintenance, line transformer maintenance and fixed charges could equitably be divided on the summation of the individual demands. This would of necessity mean that the consumer with a demand of one kilowatt would pay a

FIG. 7

RATIO OF
POWER PURCHASED AND FIXED EXPENSES
TO TOTAL EXPENSES





— FIG. 8 —

VARIATION IN AMOUNT OF CAPITAL INVESTED IN DOMESTIC AND COMMERCIAL SERVICE, PER KW. OF DEMAND.

higher service charge per kilowatt than the customer with a total demand of 5 kilowatts. From the foregoing it may briefly be summarized that a general recognition of the need of the consideration must be made of the maximum demand of each particular customer and that each be required to bear his proportionate cost of the service.

The investigations showed that it is not possible to select any group or groups within a municipality and attribute to them the use of the electric range or the appliances in question. In the study made it was found that many of the largest users of these appliances were people of average means, including laborers, night-watchmen, plumbers, book-keepers, carpenters, travellers, janitors, managers, housewives, furniture dealers, furriers, teachers, etc.

The investigation also showed conclusively that a considerable variation existed between the installed capacity and the maximum demand created, *e.g.*—customers were found in some instances to have installed capacities of 22,000 watts and with a maximum

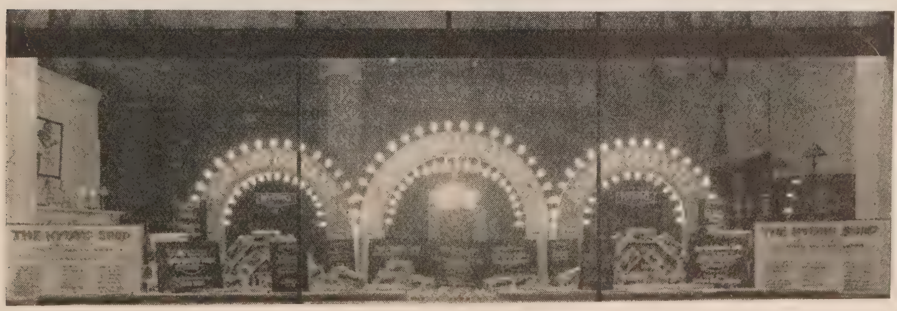
demand of less than 5,000 watts and others with installed capacities of 9,000 watts and with a maximum demand of over 7,000 watts, furthermore the kilowatt hours consumed per kilowatt of demand showed in individual cases to vary greatly.

A point worthy of note is the daily system load required to serve 2,056 electric range customers at mid-day representing about 33⅓ per cent. of the total customers. Making due allowance for day lighting, and ordinary appliances it is certain that the average demand is not less than 2,800 kilowatts or about 1.35 kilowatts per customer recorded as system peak. On this basis a load of slightly over 8,000 kilowatts would be required to supply the city when electric ranges reach the saturation point, and over 50 per cent. of this would be used only between eleven o'clock a.m. and noon.

At present during the month of July and also partially true at least during the other months, there is a peak of 2,000 kilowatts created between eleven o'clock a.m. and twelve o'clock noon which is over and above every other peak created during the day and in this part of the load there is represented about 1,000 kilowatt-hours or about 25,000 kilowatt-hours month. This at one cent per kilowatt hour would represent an income of about $250.00 and an expense of $5,580.00 providing power costs were at the rate of $2.79 per kilowatt per month.

CONCLUSION

In conclusion it would appear that the sharp peak created at noon hour by the use of the electric ranges, and against which there is very little re-sale at present, offers a problem which can at least in part be solved by the introduction of maximum demand meters on individual customers and thus encouraging the customer to suppress his maximum demand which would be to his benefit financially as well as the utility serving him. Also the introduction of a system of relays or other devices which would automatically cut out non-essential loads, such as, fire places, water heaters and refrigerators during the time the electric range was in operation would undoubtedly materially assist in the problem of reducing range peaks and improving load factors, if therefore the manufacturers could produce meters at an economic price a great deal would be done towards solving this problem.



Domestic Appliance Load Factor

By W. R. Catton, Manager, Hydro-Electric System, Brantford, Ont.

(Read before Association of Municipal Electrical Utilities at Toronto, January 24, 1929)

NO doubt we are in accord in our belief that good load factor assures success, and to attain this success, we have made a special rate for the Class "D" power customer who fills in the valleys and does not ride the peak. He is a good customer and will work to our schedule providing we have definite restrictions as to time.

The power load in Brantford produces a very flat curve from 7.30 a.m. to 5.00 p.m. The commercial lighting load is reasonably flat in the day time and then takes a natural rise in the evening, producing a paying curve. Our domestic lighting load is the one which causes our greatest worry. Any power or commercial load we may take on will be beneficial to the System; in fact, any two wire lighting service is beneficial, but when we add a three wire domestic service with all its various appliances, then our short sharp day peaks are aggravated.

In an analysis of our load conditions it was unquestionably proved that the stove customers established day demands of from 1,200 to 1,800 kw. These figures indicate and our test has proven that appliances were in operation when the stove was in use. Our experience has been that this sharp day peak becomes higher yearly and Class "D" power is not procurable to offset it. Naturally, we have a problem. One way out of the difficulty is to increase the rates. This was done in most of the municipalities, the rate was increased from two and one cents to two and a half and one and a quarter cents. I believe it was admitted at the time that the appliance load was the cause and no doubt the additional revenue cleared up the situation, but, as time goes on, the old condition will re-appear. You do not have to be a very brilliant engineer to increase rates; it is quite easy to do, providing the public do not object, but they have been accustomed to cheap power and we have not neglected advertising the fact that it is cheap, nor have we left any stone unturned in placing at their disposal all the various appliances which cause the increase in our peak.

As these appliance peaks occur at three different periods between 7.00 a.m. and 6.00 p.m., according to the season, the Class "D" power customer is eliminated, and it is this type of customer who has made and maintained the low rate per kilowatt-hour.

The above objectionable features may not apply to the larger municipalities such as Toronto, London, Hamilton, and Windsor, where the evening dinner load is offset by the drop in power load at 5.00 p.m., but in Brantford, the dinner hour is at 12.00 noon. Possibly the water heater would be sufficient to take off the peak in some municipalities, but in

Brantford, absolutely all non-essential equipment should be turned off when the stove is in use.

What have we done to educate the public in regard to this bad condition? I will admit that it is difficult, in fact, practically impossible to explain to the average layman. We hold our positions as engineers to find a way out of the various difficulties. Are we going to use the old method of raising rates or try to find some scientifically sound operating method for solving the problem?

If you agree with me in that the appliance load is pronounced in Brantford, you will admit that without means of offsetting it, we must increase our charges. Rather than do this, why not try to keep the peak down by forced co-operation. This forced co-operation would not get us into trouble if it were beneficial to the majority, and one method out of the difficulty is as follows: a lower follow up rate, providing he reduces his demand.

For argument's sake, let us assume that 4,000 watts is the fixed demand and 400 kw-hr. the approximate consumption:

Fixed Charge	.66
66 kw-hr. at two cents	1.32
334 kw-hr. at one cent	3.34
Gross Bill	5.32

A demand of 3,000 watts with a consumption of 400 kw-hr.:

Fixed Charge	.66
66 kw-hr. at two cents	1.32
234 kw-hr. at one cent	2.34
100 kw-hr. at a half cent	.50
Gross Bill	4.82

A demand of 5,000 watts with a consumption of 400 kw-hr.:

Fixed Charge	.66
132 kw-hr. at two cents	2.64
268 kw-hr. at one cent	2.68
Gross Bill	5.98

Appliances consists of:

Water heaters on flat rate	400 to 1500 watts
Water heaters metered	1000 to 3000 watts
Mantel grates	1500 to 3000 watts
Stoves	3000 to 7500 watts
Hot plates	750 to 3000 watts
Refrigerators, Air Heaters, etc.	160 to 2000 watts

I maintain that not one of the appliances should be in service when the stove is in operation, and if a study of the oven characteristics is made, you will agree that it is not necessary when the top of the stove is being used. Therefore, bill him on demand. Put it right up to him whether he pays more or less for the current. If he wishes to co-operate, make it worth his while by giving him

The customer who wants to co-operate is paid for his effort while the customer who doesn't helps to pay our costs and does not cause his neighbor's rate to be increased. The flat rate water heater will come off our peak where the customer is co-operating, automatically making the revenue from this heater practically all profit. Also, do not overlook the fact that any capacity thrown

back on us due to economies practiced by the customers is worth hundreds of dollars to us in line transformer, secondary and primary line, and substation capital expenditures.

You may say that the people will not try to keep their demands down. You might just as well say that they will not sift ashes, walk a mile to save street car fare, or the one hundred and one other things that people do to save a few cents, but if he doesn't, he pays, and so he should as in every other extravagant practice.

Discussion

Mr. H. F. Shearer, Welland: The point in Mr. Rothwell's paper that appealed to me was that the electric range is already sold. Our sales efforts should be made to get the smaller appliances in the home. Those figures that Mr. Rothwell gave showing there were only 200 watts in increase in demand by the addition of general appliances in the home, while the load factor was so materially increased, removed the problem of the electric range from the question entirely. I think that information is of great value to the executives in the various municipalities.

Mr. R. H. Starr, Orillia: I do not agree with Mr. Catton on his rate question. I think the simpler we can get the rates the better. If you have four or five or six different rates according to the demand, then you are going to have about four hundred different customers coming in and wanting an explanation when they come to pay their bill. I think the way to overcome that is to vary the charge on the demand and let the kilowatt hour rate stay. If you want two rates, well and good, but we have the one rate per kilowatt hour, and we do not have any trouble with the bills at all now. Any one can figure out his own bill. They get their reading and know what it is immediately. If you were to make a charge on the four kilowatt demand, and charge thirty or forty or fifty cents and if it is over that, you want to make a higher rate to go up around seven or eight kilowatts demand, well and good; but don't get on to having half a dozen rates per kilowatt hour according to demand or consumption.

Mr. Catton: The point in connection with making the charge on the demand is quite right. But you say you have one rate per kilowatt hour. You are disregarding demand. I could put on six kilowatts for a half hour and another fellow could put on three kilowatts for one hour and our bills would be exactly the same. That is the thing we are trying to overcome. We want to sell a lot of kilowatt hours. We want a lot of appliances and a lot of stoves too. We want to educate the people in the proper economical use of these appliances, so they can use more of them and use them longer and help to give us a load factor.

Mr. E. V. Buchanan, London: Mr. Rothwell referred, at the beginning of his paper, to service at cost. Now, what is service at cost? What is cost? The cost of electrical service to a class of consumer or to an individual customer defies scientific analysis. If you can imagine a plant starting up to serve one lighting

customer, it is very easy to determine what that customer shall pay, because he must pay the total cost of operating that plant. As the plant continues, however, and it is found that, during the day time, when no power is being used by the lighting customer, a power customer appears. What shall we charge the power customer? It is a by-product entirely of this plant, especially if the plant is a hydro-electric plant and is not consuming any fuel. In the case of the principle of the Hydro-Electric Power Commission, it is supposed to be power at cost. Now what is the cost of adding this additional consumer? Shall we only charge the lighting consumer with all the cost so far, and then charge the power consumer with the additional cost? Then, take the opposite case. Suppose this plant were started up to supply a power consumer; you charge the power consumer with the original cost and later the lighting consumer comes and you may charge the lighting consumer with the additional cost; or do you split it up on the basis of peak load or on the basis of kilowatt-hour consumption, or do you take into consideration the load factor, the diversity factor, and so on? You can go into many ramifications. Later, you probably get a number of different lighting consumers' characteristics and a number of different power consumers with different characteristics, and I come back to the point I mentioned at the beginning, that the cost of the electrical service to a class or to an individual consumer defies scientific analysis.

Now, it is proposed, I believe, by Mr. Catton to put in some kind of demand meter to control the peak of the domestic customer's load. The objection that I have to demand meters is that you increase enormously the cost of billing and collecting. Your meter reader's time would be very considerably increased. Your fixed charges on the cost of the additional meter would run your bill up and the work of billing would be tremendous. Where you have to vary the demand, as I presume Mr. Catton intends from month to month, it would mean that it would hardly be possible to use the machine billing systems as many of us do now, and particularly, as Mr. Starr mentioned, you would have tremendous complaints from the customers. In a city like London, where we have 18,000 domestic consumers and 500 power consumers, it is very easy to explain to the manufacturers, the reason for demand billing and for sliding kilowatt rates; but to attempt to explain to 18,000 domestic consumers the reason why in any one month you should charge \$2.00 for 100 kilowatt hours and in another month you should charge him \$4.00 for 100 kilowatt hours—I don't believe it could be done. I don't believe that the demand is a very big factor in the cost of domestic service. It is one of the factors, but the time of the demand is another factor, the load factor is another one, and to blame the stove load for all our troubles is rather unfair. I do appreciate that there should be some difference in the service charges. Yesterday you all heard the report of the Rates Committee where it was suggested

that there should be two or more service charges for domestic consumers. It might be 33 cents for the two-wire service, 66 cents for the three-wire service up to 25 amperes, and 99 cents for services larger, and then have a corresponding number of kilowatt hours at the first rate such as thirty for the small consumer, sixty kilowatt-hours for the intermediate one, and ninety kilowatt-hours for the larger one. Then you would have very little trouble in your billing, because the consumers would be billed similarly each month and you would have no expense for demand meters.

I am quite in accord with the second conclusion drawn by Mr. Rothwell, to adopt some method of flattening out your load curve by restricting the other appliances. To my mind, that is more easily done by getting such business as the water-heater off the station peak, no matter when it occurs. It appears to me that it can be done very economically by either of two ways: first, by adopting the system of what the Westinghouse call the resonant control which has been used in the United States for the control of street lighting. By that method, you could control the water heaters from the station. Another method of accomplishing the same thing is by using a relay on a pilot circuit. In London, we have over 1,000 water heaters of one h.p. demand on the average. 1,000 h.p. costs in power alone twenty-six dollars per horsepower at the station, twenty-eight perhaps at the consumer's premises. If you could cut these water heaters off the peak load, you could reduce your cost of power by $28,000 per year. Now you can easily see that municipalities could afford to spend a considerable amount of money to accomplish that. You could easily cut these water heaters off for fifteen or twenty minutes or half an hour, and the consumer would never know that it had happened, because with flat rate water heaters with a fairly large storage tank, he would not have realized that he had been without power for that time. You could cut the water heaters off at noon or in the evening, or during the time of the Hydro-Electric Power Commission's peak, if that is the vital factor, as well as the time of the local peak. Mr. Catton remarked that, if you could get all the other appliances cut off, it would not compensate for the stove peak. Mr. Shearer pointed out that the solution of the problem was to sell other appliances; and I think that that is part of the solution. But I am inclined to think that Mr. Catton is not correct when he says that it is impossible to counteract the stove peak by cutting off these other appliances. What I am afraid of is that, if we develop the water heater business, as no doubt it will develop—and cut the water heater off our stove peak we will produce peaks at some other part of the day—at ten in the morning or three in the afternoon. But even then, you still have the opportunity of creating a diversity factor in the use of water heaters by the cutting of half of them off at one time and half at another time.

Mr. Catton: Mr. Buchanan does not like the trouble of this extra meter reading and billing; yet he does not mind spending a few thousand

dollars in equipment to try and control it. In other words, it is a little easier to spend money than it is to try and collect it. The Blue Book of 1927 by the Hydro-Electric Power Commission is all a matter of dollars and cents and the cost of electricity to the public. London bought power a little cheaper than Brantford did in 1927. The people were charged two and one cents per kilowatt-hour in Brantford, where we paid a little more for power. The people in London were charged two and a half and one and a quarter cents where they bought cheaper power than we did in Brantford. We want to make it still cheaper. We don't want to put on that extra half cent that London has. We want to put it up to the people themselves and pay them for their effort. We feel we can educate the people into the economical uses of appliances by restricting their loads, thereby taking non-essential loads off our peak. We have not encouraged flat rate water heaters in Brantford. I feel that, if we have a 750-watt heater connected flat rate, we are just getting our cost. If it is taken off our peak, it is that much saved and we can hand it back in cheaper current. But the water heater is not enough, to cut off the peak. Mr. Rothwell wanted me to bring this to your notice to show that appliances are used indiscriminately. On January 19th, when it was 32 degrees above zero, our demand was 7,100 kilowatts. When it was 26 above zero, on January 17th, it was 7,800 kilowatts. On January 30th, when it was 13 above zero, the demand was 7,900 kilowatts, and when we had a zero morning on January 14, there were 8,400 kilowatts. It simply means that the people turned on everything they had for half an hour, to warm up the place which gave us a tremendous peak at eight o'clock in the morning.

Mr. J. E. B. Phelps, Sarnia: We are selling a commodity which is used in the residences by the women. They are going to do a thing when they want to do it. You fellows are all engineers, and engineers deal with facts and you get so close to the problem that you lose the viewpoint. We have to supply this current to the homes of our people and give them service, and we have got to produce some kind of rate that will take care of the situation. I think if we have a customer with a demand of one kilowatt, we should make him pay thirty cents of a service charge and fifteen cents billing charge, (that is about what it costs us, if you go through the blue book), that will make his service charge forty-five cents a month. Let the man with a three-wire service, sixty ampere box, pay ninety cents service charge, and add fifteen cents billing costs, and you get $1.05 from him. From the five kilowatt man you get $1.65 on that basis. With a rate per kilowatt hour for fifty hours a month, we should take care of the total cost of the power. Then give half a cent follow-up rate to encourage the use of appliances, and you will have a good load factor. That is my idea of the solution. Demand meters may be necessary.

Mr. Buchanan: I just want to say that Mr. Catton's demand meters might cost as much as the relay system which I propose.

Mr. R. H. Martindale, Sudbury: Is it not a fact that, to get at the real solution of the question the only proper way is to measure the demand and charge for what is used? Any other measures are only partial, and if the demand meters can be brought down to a cost somewhat lower than they are, it will mean that that is going to be a solution of this question and every customer will be free to use all or any of his equipment. Water heaters are not the only sinners. There are also electric grates and other appliances. It seems to me that measurement of the demands, with as simple a rate as possible, is the solution of the question. Each customer can then determine his own bill and put on as much as he likes and he pays for it accordingly.

Mr. R. T. Jeffrey, H.E.P.C., of Ontario: The Power Commission Act states that service shall be supplied at cost, and our duty in the H.E.P.C., is to see that that service is supplied at or as near cost as we can determine.

Mr. Buchanan has said that it is absolutely impossible to scientifically analyze the cost of service to individual consumers. I agree with him. But it is our duty to go as far as we can in determining and fixing a rate with your assistance, that will give service to each consumer at as near cost as we possibly can, depending on the service he gets and the cost of supplying that service.

Mr. Starr has made a suggestion, which I only partly agree with, that we might vary the service charge to get part of the cost from the consumer who uses the current, and use a flat meter rate. It is an easy way to get money but it is not a just way. The matter of load factor of the various municipalities is one that has not been given perhaps as much consideration as it should in a sensible way. We have considered the contracts under which the power is being supplied, and we have been advised that, under those contracts, the Commission may determine the items to be considered as cost. As I have said before at other meetings of this kind, there is coming a time undoubtedly when load factors is going to be one of the factors that will enter into the cost of power as billed to the various municipalities, and that is only fair. It hardly seems fair that one municipality having a load of a thousand horse power with a load factor of thirty per cent. should pay as much for that power as the municipality with a load factor of perhaps fifty per cent. Furthermore, the cost of that power, as far as the Commission is concerned, is entirely different to what it was at the time those contracts were first entered into. We bought power at that time on a peak basis, and the cost of power, as far as we were concerned, was the same regardless of load factor. At the present time that condition, on practically every system which we operate, has changed, and the load factor is one of the important factors, almost as important as the peak load. At Niagara Falls, we are up to our water capacity, as we are in practically all of the other systems. The contract which we recently entered into with the Gatineau Power Company is based on the seventy per cent. weekly load factor, and as the municipalities increase their load factor,

they increase the cost of power, and if one municipality increases its load factor higher than the others, it should pay a correspondingly higher rate for its power, and that is, I believe, undoubtedly coming. So, when you talk of increasing your load factor, you have to keep that point in mind. I do not say that the charge would be prohibitive, but there will be some increase in the cost, due to the increase in load factor. We have tried to keep pace with the information we have in the form of our rates. The rates have been changed from time to time, and they undoubtedly will be changed in form from time to time to keep pace with the advance of the science of measurement and supply. We have been investigating the matter of relays, of interrupting devices and of demand meters. The demand meter manufacturers have recently brought out meters which have helped to solve our problem in the matter of commercial requirements as well as the smaller customers, and will help to solve the problems we have to face as the domestic appliance load increases. We are trying to give all the encouragement, help and assistance we can to the meter manufacturers and the relay manufacturers; and all I can say is that, as far as the rate structure is concerned, we will endeavour to keep pace with the advance of the science in that regard. I think that the investigations that Mr. Catton has made will help us very materially to clear up a very knotty problem. The analysis of the operating costs of the various municipalities is based on a analysis which was devised by the H.E.P.C. Rate Committee and revised from time to time, based on information we obtained, not only at these meetings, but from individuals in the various municipalities. We have received a lot of help and a lot of criticism in connection with that analysis. We have changed it from time to time, and undoubtedly we will change it from time to time as we see some better way of arriving at a nearer solution of the cost. We do not think it is perfect and are willing to change it at any time, in any particular in which we see that it will be improved.

Mr. J. W. Peart, St. Thomas: Mr. Chairman, I do think, in view of the discussion that has occurred this morning, it should be our duty to see that a follow-up paper is prepared and presented at the Summer Convention along these lines so as to bring out or give us an idea as to the increase in our operating costs were we to turn over to the demand meter method of measuring domestic services. I feel sure that we are all in accord with the principle that Mr. Catten and Mr. Rothwell have outlined this morning as the one that we are all looking forward to. The question as to the practicability of that method remains to be determined. We do not know how it will affect our billing costs, the meter reading costs and just what it will mean to a local system. It may be that the demand meter is not the solution that we are looking forward to. There may be another solution, depending on the method of resonant control that Mr. Buchanan has referred to. I believe there are certain municipalities, not in our Hydro

family, who depend on duplicate metering, and it would be quite possible, if some method of control on the potential coil of the meter were installed, to throw the second meter on to the consumers' service during peak load hours and charge a higher rate during the peak period.

Association of Municipal Electrical Utilities

Committee Reports

Auditor's Report

Mr. J. G. Archibald,
President,
Ass'n of Municipal Electrical Utilities of Ontario.

Dear Sir,—

We beg to advise you that we have audited the books of the Association of Municipal Electrical Utilities for the calendar year 1928, and find that the cash received and recorded by the Treasurer agrees with the Secretary's statements. The disbursements are supported by vouchers duly authorized and passed by both President and Secretary, and the cash balance is in accord with the account at the Bank.

We respectfully submit herewith statement of Receipts, Disbursements and Assets.

Yours very truly,
W. G. PIERDON,
H. P. L. HILLMAN,
Auditors.

STATEMENT OF RECEIPTS, DISBURSEMENTS AND ASSETS FOR YEAR ENDING DECEMBER 31st, 1928

RECEIPTS

Cash in Bank, December 31, 1927		$ 703.24
Membership Fees—Utilities	$1,281.00	
Commercial	350.00	1,631.00
Convention Receipts—January	$1,426.00	
June	1,582.50	3,008.50
Interest on deposits		39.34
Interest on bond		27.50
O.M.E.A. contribution		110.86
		$5,520.44

DISBURSEMENTS

Members' Travelling Expenses	$ 144.05
Secretary and Treasurer remuneration	250.00
Printing	92.00
Postage	17.50
Bank exchanges on cheques	20.70
Miscellaneous expenses	4.58
	$528.83

Convention Expense—		
Luncheons	$2,786.50	
Entertainment	355.60	
Reporting	195.75	
Badges	181.99	
Printing	116.72	
Sundries	87.68	
		3,724.24
Balance		1,267.37
		$5,520.44

ASSETS

Cash in Bank		$1,267.37
Dominion 5½% 1934 Bond, (par $500), cost		513.50
Lantern and fixtures	$243.45	
Less 5% per annum written off	109.55	
		133.90
O.M.E.A. proportion of June Convention expenses		39.11
		$1,953.88

Papers Committee Report

The papers to be given were decided on by the Papers Committee, and it has not been done without a great deal of work. The Papers Committee have striven to get the best papers they could, but it is a very difficult matter to get papers which the Committee feel would be interesting to all the municipalities and to all our members. The trouble that the Committee runs us into is the fact that a paper which might be of interest to the larger cities is not of interest to the smaller municipalities. I am sure that I voice the opinion of the Papers Committee when I say that we would like to have suggestions from the members as to what is on their mind and what they would like to have discussed at the Convention. I am sure any suggestions that any of the members have would be appreciated by the Paper's Committee and assist them in arranging the program.

I want to thank the members of the Committee for their assistance during the past year, and I hope the papers which we have arranged for this Convention will be found suitable.

O. H. Scott,
Chairman.

Regulations and Standards Committee Report

Your Regulations and Standards Committee have to report as follows,

Wiring Regulations

The Canadian Electrical Code which was prepared by the Canadian Engineering Standards Association and in the preparation of which the Commission co-operated, was adopted by the Commission and put in force in 1928. The preparation of this

Code, as you are probably aware, occupied several years' time and was completed by the Committee after overcoming many difficulties, one of the most important of which was the wide separation between the different Provinces and the existence of local rules in the various municipalities and Provinces. The first edition of the Code was authorized at a meeting early in 1928, when they were adopted by the Commission as noted above.

They have received a very favorable reception in this Province as well as in others and it is apparent that they have supplied a long felt need.

In September 1928, a revised edition of the rules was approved and will be published in the course of a few weeks. The revised rules embody several new features which should work to the advantage of the industry. Among these may be mentioned rules for the grounding of portables in industrial establishments, simplified rules for motor installations and protection, the introduction of demand factors permitting a reduction in wire sizes of mains in the case of large installations having varied load requirements.

The Canadian Engineering Standards Association is now considering the preparation of outside rules.

Electricity Inspection Act.

As noted in previous reports of this Committee, a considerable amount of work has been done by a Committee including representatives of the A.M.E.U., the Commission and the Canadian Electrical Association, towards obtaining a revision of the Electricity Inspection Act which would be satisfactory to the industry. This Act was revised at the last session of the Dominion Parliament and the Electricity and Gas Inspection Department is now preparing regulations based upon this Act. The Committee is still working with the Department with the view to having these Regulations satisfactory both to the industry and to the Department.

The principal points which have been under discussion and the final decision regarding them are indicated below:

1. Period for reseal of meters.

It was endeavored to have this period extended from five years to a much longer period and the Act now states that the reseal period shall be six years.

2. The Sealing of Meters.

Other than watt-hour meters, the original Act required that all meters used for billing purposes should be sealed. As this was impracticable in the case of graphic meters and many types of demand meters, it was endeavored to have this provision changed and the Act now provides that the National Research Council shall be the final arbiter in the matter of approval of types of meters for billing purposes and the Council may also approve meters for use unsealed.

Several other matters now under discussion have not been carried to a decision and it is hoped that a further report may be made at the next Convention.

All of which is respectfully submitted,

R. J. Smith,
Chairman.

Committee on Accident Prevention and Health Promotion Report

Your Committee on Accident Prevention beg to report:

A meeting of this Committee has been held at which considerable discussion resulted on matters pertaining to accident prevention.

Meetings have been held throughout the Province during the past year by Mr. Wills Maclachlan under the auspices of the Electrical Employers Association which were of a general educational nature. These meetings were well attended by representatives of the municipalities and by others interested in safety matters and we recommend that these meetings should certainly be continued, as they have proved beneficial in accident prevention.

A new booklet on Prone Pressure Methods of resuscitation has been published and copies have been forwarded to the municipalities connected with the E.E.A. and H.E.P.C. Any members of the Association who have not received copies may procure same by applying to Mr. Maclachlan.

All of which is respectfully submitted,

H. G. HALL,
Chairman.

Merchandising Committee Report

The Merchandising Committee did not hold any meetings during the past year for the reason that there were no very important matters to discuss for the benefit of Hydro Shops in Ontario. There is one matter, however, which has been receiving some consideration and that is the matter of general advertising to increase the use of appliances among Hydro consumers.

For some time an effort has been made to have made available for the Hydro Shops in Ontario the general advertising matter which the Toronto Hydro-Electric System have prepared for them by an advertising agency in Toronto.

The J. J. Gibbons Advertising Agency are at present in charge of Toronto Hydro advertising and in approaching them on the matter they advised as follows:

"We are pleased to report to you that the Toronto Hydro-Electric System have given us permission to make available to you all engravings and copy used in Toronto Hydro Appliance and Red Seal advertising. You will be supplied with proof sheets from time to time showing the illustrations which are available. You may order any quantity of mats and stereotypes or electrotypes for use by the Hydro Shops in Ontario. These will be charged to you at the prevailing prices for same plus 15 per cent. service charge. You will also be charged with any other expenses such as printing, postage and shipping charges. A typical three column Hydro illustration costs about $40.00 or $45.00 to prepare. A stereotype of this would cost us in Windsor about $2.35. Advertisements in two columns and up to page size could be supplied at correspondingly low prices.

A few proof sheets are being prepared now to show a number of advertisements clearly numbered with an order form attached and will be

submitted to you shortly so that this service may be put into operation."

As soon as the necessary arrangements can be made with the J. J. Gibbons Company all the Hydro Shops in Ontario will be notified of the arrangements under which they can secure stereotypes or mats of Toronto Hydro advertisements to enable them to secure the benefit of the service of an up-to-date advertising agency at a low cost.

All of which is respectfully submitted,

J. E. B. PHELPS,
Chairman.

Rates Committee Report

Your Rates Committee beg leav to report as follows:

Since the June Convention our Committee has held one meeting which took place on July 12th last at Toronto. The following were present: Messrs. V. S. McIntyre, Chairman; P. B. Yates; E. M. Ashworth; J. R. Smith; O. H. Scott; J. E. B. Phelps; V. B. Coleman; R. L. Dobbin; E. V. Buchanan; J. W. Peart; D. B. McColl; H. J. McTavish; R. T. Jeffery and S. R. A. Clement.

This meeting was called at the request of the Hydro-Electric Power Commission and Mr. R. T. Jeffery on behalf of the Commission announced that the purpose was to obtain an expression of opinion regarding a proposal of the Commission to increase the domestic service charge where permanently installed appliances of the larger capacities are used. The proposal was to make the gross service charge 66 cents where the total installation in a house is 2,000 watts or over. The suggestion brought forth considerable discussion and other suggestions were made towards obtaining the same end as follows:

(a) That instead of using the installation as a basis for fixing the higher service charge, that the present service charge of 33 cents gross be used where two-wire service is given and 66 cents gross for three-wire service.

(b) That the service charge be graded on meter capacity as for example, two-wire meters of 5 and 10 amperes, be billed at 33 cents gross, that three-wire meters of 15 and 25 amperes be billed at 66 cents gross and that there be a third step of 99 cents applying to three-wire meters of the higher capacities.

After an extended discussion of the proposal and the suggestions, it was moved by Mr. P. B. Yates and seconded by Mr. J. E. B. Phelps, THAT this Committee approve the suggested change in domestic rates, that is, that there shall be two or more standard service charges, but we would ask that there be allowed, where advisable or desirable, a change in the kilowatt-hours at the first rate for small demand class of users. Carried.

The members of the Committee voted as follows:

IN FAVOR	CONTRARY
Yates	Ashworth
Coleman	Peart
Phelps	
Dobbin	
Buchanan	
Scott	NOT VOTING
Smith	McColl

An amendment to this motion was moved by Mr. E. M. Ashworth and seconded by Mr. J. W. Peart, THAT prior to being forwarded to the Hydro-Electric Power Commission of Ontario, the Resolution be submitted to all local Commissions affected, for their comments. This Resolution was lost, the voting being as follows:

IN FAVOR	CONTRARY
Ashworth	Yates
Peart	Coleman
Buchanan	Phelps
	Dobbin
	McColl
	Scott
	Smith

Mr. E. V. Buchanan referred to a Resolution passed at the meeting of this Committee held in Kitchener, on November 29th last, "THAT the Hydro-Electric Power Commission of Ontario add two columns in statement "D" of the annual report showing the kilowatt-hours used for power and the average price per kilowatt-hour." The meeting was advised that the Commission had taken action on this Resolution and that the report for next year would include the columns requested. There being no further business the meeting adjourned at 4.15.

All of which is respectfully submitted.

V. S. McIntyre,
Chairman.

Minutes of Convention

The twenty-fourth Convention of the Association of Municipal Electrical Utilities was held at the King Edward Hotel, Toronto, on January 23rd and 24th, 1929.

Prior to the opening session, the delegates met with the Ontario Municipal Electrical Association and The Electric Club of Toronto for luncheon, when an address was given by Rev. G. W. Tebbs, Burlington, Ont.

The first session of the Convention was called to order by Mr. J. G. Archibald, President, at 2.50 p.m. on January 23rd.

It was moved by Mr. E. V. Buchanan and seconded by Mr. E. I. Sifton THAT the minutes of the preceding Convention, which had been published in the Bulletin, be taken as read.—*Carried.*

The President gave a short address welcoming the delegates to the Convention.

The Auditors' report was read which showed the Association in a healthy financial condition, the bank balance having increased from $703.24 to $1,267.37 during the year 1928, with assets amounting to $1,953.88. It was moved by Mr. J. E. B. Phelps and seconded by Mr. J. W. Peart, THAT the Auditors' report be adopted.—*Carried.*

The names of Messrs. J. S. F. Madden, D. I. Nattress, E. W. Smithson and W. V. Bishop, having been presented for election as Associates, it was moved by Mr. J. W. Peart and seconded by Mr. E. V. Buchanan, THAT they be declared elected.—*Carried.*

Reports of Committees were then presented.

Mr. O. H. Scott, Chairman, Papers Committee, spoke of the work of that Committee in obtaining papers, and asked for suggestions from the delegates for papers for future conventions.

Mr. R. J. Smith, Chairman, Regulations and Standards Committee, presented a report from that Committee and moved its adoption. Being seconded by Mr. E. I. Sifton, the motion was carried.

The Report of the Committee on Accident Prevention and Health Promotion was presented by Mr. H. G. Hall, Chairman, who moved its adoption. This motion was seconded by Mr. C. T. Barnes. Mr. G. F. Drewry gave a short address on the work of the National Safety Congress. The motion was then carried.

Mr. J. E. B. Phelps, Chairman, Merchandising Committee, presented Mr. G. J. Mickler, who read a letter advising that the advertising prepared for the Toronto Hydro-Electric System was available to all of the other utilities at nominal costs, and that proof sheets would be submitted shortly. After Mr. Mickler had explained the opportunity offered for advertising, Mr. Phelps moved THAT the report be adopted. On being seconded by Mr. E. V. Buchanan, the motion was carried.

A report from the Rates Committee was presented by Mr. V. S. McIntyre, Chairman, who moved its adoption. This motion was seconded by Mr. E. V. Buchanan and carried.

Mr. E. V. Buchanan spoke of a discussion that took place at a meeting of the Ontario Municipal Electrical Association that morning, that the Hydro-Electric Power Commission be asked to consider carrying on research work in its laboratories, and moved THAT the Hydro-Electric Power Commission be requested to submit a report at the next meeting of the Association, showing the extent to which it is possible to extend the work of testing and research in the Commission's Laboratories. Mr. V. S. McIntyre seconded this motion, after which it was carried.

The Secretary made an announcement of changes that had to be made in the Convention programme after being published.

Mr. Everett S. Lee, Research Engineer, General Engineering Laboratory, General Electric Co., Schenectady, N.Y., read a paper entitled "Lightning Investigations." Discussion following Mr. Lee's paper was by Messrs. E. V. Buchanan, R. H. Starr and G. D. Floyd.

Mr. J. S. Keenan, Industrial Heating Specialist, Canadian General Electric Co., Toronto, read a paper on "Industrial Heating." Discussion following this paper was by Messrs. T. R. C. Flint and E. V. Buchanan.

It was moved by Mr. E. V. Buchanan, and seconded by Mr. J. W. Peart, THAT a hearty vote of thanks be extended to Mr. Lee and Mr. Keenan for their very excellent papers.—*Carried.*

The results of the election of officers for the year 1929 were then announced, those elected being—

President—A. W. J. Stewart

Vice-President—R. L. Dobbin

Secretary—S. R. A. Clement

Treasurer—D. J. McAuley,

Directors—R. H. Starr, O. H. Scott and J. E. B. Phelps.

District Directors—

Niagara District—J. W. Peart; Central District — W. E. Reesor, Georgian Bay District—J. R. McLinden; Eastern District—A. L.

Farquharson; Northern District—T. W. Brackinreid.

The session then adjourned.

At 7.00 o'clock that evening the delegates met with the Ontario Municipal Electrical Association at the Convention Dinner, Mr. C. A. Maguire, President, O.M.E.A. being toast master. There was no special speaker but Controller Wemp, representing the Mayor of the City of Toronto, gave a short address welcoming the two Associations. Mr. F. A. Gaby, Chief Engineer, H.E.P.C. of Ontario, also spoke, giving a brief outline of the financial condition of the Commission.

The second session of the Convention opened at 9.30 a.m., on January 24th.

Mr. H. D. Rothwell, Municipal Engineer, H.E.P.C. of Ontario, read a paper entitled "Investigation of Domestic Demand." This was followed by a paper by Mr. W. R. Catton, Manager, Hydro-Electric System, Brantford, on "Domestic Appliance Load Factor." Discussion following these two papers was by Messrs. H. F. Shearer, R. H. Starr, E. V. Buchanan, J. E. B. Phelps, R. H. Martindale, R. T. Jeffery and J. W. Peart.

Mr. K. A. McIntyre, Managing Director, Society for Electrical Development, Inc., New York, gave an address on "Suggestions for Commercial and Market Development." It was moved by Mr. A. O. Hunt, and seconded by Mr. A. B. Scott, THAT a vote of thanks be extended to Mr. Rothwell, Mr. Catton and Mr. McIntyre for the papers presented by them.—*Carried.*

Honourable I. B. Lucas, General Solicitor, H.E.P.C. of Ontario, gave an explanation of the Pension and Insurance scheme for Municipal Hydro employees, which was about ready to be put into action, and answered questions by the delegates regarding the same.

Mr. D. B. McColl presented a resolution regarding group insurance of property as follows:

> WHEREAS—at the 1927 session of the Legislature, the Power Commission Act was amended so as to make compulsory on the part of all municipalities having a contract with the H.E.P.C. for the supply of electrical energy, the carrying of insurance against loss and damage to the persons and property of employees and others, except in such cases where insurance funds are maintained with the approval of the Commission—and
>
> WHEREAS, practically all such municipalities are now carrying protection against employers' liability with the Workmen's Compensation Board on a very satisfactory basis, and
>
> WHEREAS, the minimum premium of $50.00 per year charged by all insurance Companies for public liability and property damage is a heavy burden on many of the smaller municipalities and difficult to justify in view of the fact that claims for compensation under such policies are rare.
>
> BE IT RESOLVED that this convention of the Ontario Municipal Electrical Association and the Association of Municipal Electrical

Utilities hereby request the Hydro Electric Power Commission to endeavor to arrange with some insurance company or companies for group insurance covering public liability and property damage, which will be available to the smaller municipalities somewhat on the basis used by the Workmen's Compensation Board and without the present burdensome minimum charge, as authorized by Paragraph 4 of Section 86 of the Power Commission Act.

This resolution was referred to the Executive Committee.

The President then presented Mr. A. W. J. Stewart, President-elect for the year 1929, after which the proceedings closed.

At 12.30 p.m. the delegates met with the Ontario Municipal Electrical Association for luncheon when Mr. F. A. Gaby, Chief Engineer, H.E.P.C. of Ontario gave an address on "The Gatineau-Leaside Project" which was followed by movies showing the work, the speaker being introduced by Mr. T. L. Church, M.P.

Following luncheon the delegates made a visit to the Leaside Transformer Station.

The register shows the total attendance at the Convention to have been as follows:

Class A	89
Class B	119
Commercial	58
Associates	40
Visitors	13
TOTAL	319

There were 283 present at the luncheon on the first day, and 328 at the Convention Dinner. The attendance at the luncheon on the second day was 287.

SUMMER CONVENTION

O.M.E.A. and A.M.E.U. will be held at

BIGWIN INN, LAKE OF BAYS

JULY 3, 4 & 5, 1929.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Annual Report of the Hydro-Electric Power Commission for the Fiscal Year, 1928

Short Summary of Important Matters Contained in the Report Submitted to the Provincial Government and Tabled on March 8, 1929.

THE report of the Hydro-Electric Power Commission of Ontario, (hereinafter called the Commission) as tabled, presents the results of the operations of the Commission in the generation, transformation and transmission of electrical energy to the co-operating municipalities. The data presented is up to the close of the Commission's fiscal year, October 31, 1928.

During the past year, the work of the Commission has been characterized by a steady growth on all systems, as is shown by the following tabulation of system loads for the years 1927 and 1928, and this increase in load during the past few months has been maintained:—

DISTRIBUTION OF POWER TO SYSTEMS
(20-Minute Peak Horsepower)

System	October 1927	October 1928
Niagara System and Export	810,322	879,357
Georgian Bay System	19,247	20,082
St. Lawrence system	8,246	9,896
Rideau System	3,290	3,351
Thunder Bay System	43,603	48,910
Ottawa System	18,480	20,241
Central Ontario & Trent System	43,458	47,493
Nipissing System	3,054	3,170
TOTAL	949,700	1,032,500

CONTENTS

Vol. XVI No. 3

March, 1929

	Page
Annual Report of the Hydro-Electric Power Commission for the Fiscal Year, 1928 - - -	65
Exterior Lighting, Toronto-Leaside Transformer Station - -	70
Status of Lightning Surge Investigations in the United States -	72
Suggestions for Electrical Development - - - - -	82
Insurance aud Superannuation Plan for Municipal Commission Employees - - - - - -	88
Protective Relay Installation at the Toronto - Leaside Transformer Station - - - - - -	93
O.M.E.A. Report - - - -	101
A.M.E.U. Report - - - -	106

Niagara System

As there are no large power developments under construction by the Commission at the present time to serve the Niagara System, and as all the available power from the Commission's Niagara generating plants was in use at the end of the year 1928, the Commission entered into a long-term agreement with the Gatineau Power Company, with generating plants located in the Province of Quebec, for 260,000 h.p., to be delivered on the Ottawa River at the Provincial boundary, to augment the power supply of the Niagara System and during the year a steel tower transmission line was constructed from the Ottawa River to Toronto to transmit this power at 220,000 volts at an expenditure of about $3,000,000. This additional source of power supply will add much to the continuity of service supplied from the Commission's present sources of power from the Niagara System, and plans are now under way for the construction of a second transmission line between the Ottawa River and Toronto, which will further add to the reliability of the service. The first block of this power, some 80,000 h.p. was delivered in October 1928, and the contract provides for additional power as required until the maximum is being used.

Georgian Bay System

The increase in load on the Georgian Bay System necessitated the commencement of the construction of work on a new development at Trethewey Falls on the Muskoka River, which will have a capacity of 2400 horsepower, and a study was made and a report submitted regarding the matter of further developments to supply this system with additional power from plants on the Musquash River, with total capacities in three or four sites of 40,000 horsepower, and work on a new development to obtain power from the Musquash River or some other development must be proceeded with during the present year, such as a connection with the Niagara System.

Thunder Bay System

The demand for power on the Thunder Bay System was increased by 5300 horsepower during the fiscal year and by over 10,000 horsepower during the calendar year over the peaks used during 1927. This rapid increase in the power requirements of industries in this district has made it necessary for the Commission to consider the matter of proceeding with the development on the Nipigon River at Alexander Landing. Work on this development is already under

way and when completed will add an additional capacity to the system of approximately 54,000 horsepower.

Eastern Ontario System

The growth of the loads carried by the various systems in the eastern part of the Province has exhausted all the available supply from the generating plants supplying these systems, making it necessary for the Commission to obtain an additional source of power supply. The Commission called for tenders during the year 1927 on a large block of power for use on the four systems in eastern Ontario and finally entered into a contract with the Gatineau Power Company for a maximum of 100,000 horsepower at a very advantageous rate. The contract provides that this power shall be taken and paid for in minimum blocks of 6,000 horsepower per year for the first ten years.

This arrangement provides for power being supplied from one source to meet the growth in load on the four eastern systems, and one hundred and fifty miles of transmission lines were constructed during the year to transmit this power from the Interprovincial boundary on the Ottawa River to the Ottawa, Rideau, St. Lawrence and Central Ontario Systems, and through this agreement these four systems have available sufficient power to meet all the requirements for possibly a number of years, although it is hoped the favourable conditions attending the supply of this power will help to bring about a much greater activity in industrial development in this part of the Province.

Nipissing System

The generating plants supplying power to the Nipissing System are loaded to capacity and during the year construction work has been carried on on a new generating plant at Elliott's Chute, having a capacity of 2400 horsepower, which is expected to be put into operation during the present year. This additional power is expected to meet the growth in the district during the next three or four years.

Rural Power Supply

During the year, the Commission was very active in constructing lines to serve rural consumers in different parts of the Province, and during the year about 1,000 miles of new rural lines were completed and it is expected that this programme will be maintained for at least a number of years to come. The following tabulation shows the progress made in rural supply between 1922 and 1928:—

	1922	1928
Miles of Primary Lines.......	320	4,103
Number of Rural Consumers ..	2,226	31,063
Load in Horsepower..........	393 h.p.	16,980 h.p.
Total Expenditure...........	$681,891.49	$8,951,779.14
Bonus......................	$190,574.07	$4,464,708.85
Rural Power Districts........	27 Comprising 85 Townships	131 Comprising 233 Townships

The total capital investment of the Commission in power undertakings and Hydro-Electric Railways, including expenditures made by the Municipalities, is over $300,000,000.00. This expenditure is made up as follows:—

Niagara System	$161,994,023.61
Georgian Bay System	3,546,340.02
St. Lawrence System	1,852,165.93
Rideau System	1,189,021.46
Thunder Bay System	14,332,937.23
Ottawa System	201,331.53
Eastern Ontario Systems, transformer stations and Transmission Lines	895,236.64
Central Ontario and Trent Systems	14,157,630.78
Nipissing System	1,151,370.92
Office and Service Buildings, construction plant, Inventories, etc.	2,908,076.46
Hydro-Electric Railways	6,989,346.88
	$211,217,481.46
Approximate Municipal Expenditure	89,000,000.00
TOTAL (approximate)	$300,000,000.00

The following statement summarizes the Commission's collections from municipal hydro-electric utilities and other power customers for the year and shows how the collections have been appropriated.

The Commission collected from the municipal utilities and other customers, for power sold, a total sum of $24,287,296.23. This sum was appropriated to meet all the necessary fixed charges and reserves and to provide for the expenses of operation and administration. After meeting all charges, there was left a net credit to surplus on power costs of $940,663.07.

Revenue from municipal electric utilities and other power customers		$24,287,296.23
Appropriated as follows:		
Operation, maintenance, administration, interest and other current expenses	$16,489,620.67	
Reserved for sinking fund, renewals, contingencies and obsolescence	6,857,012.49	
		$23,346,633.16
NET SURPLUS after providing for all expenses and necessary fixed charges, credited to municipalities		$940,663.07

Taken as a whole, the financial results of the Commission's operations for the year and to date have been most satisfactory, and the following tabulation shows the accumulated reserves of the Commission for sinking fund, renewals, contingencies and other purposes. These reserves amount to approximately,—$37,500,000.00, made up as follows:—

Niagara System	$28,989,376.26
Georgian Bay System	1,417,747.44
St. Lawrence System	379,504.86
Rideau System	258,860.96
Thunder Bay System	954,005.63
Ottawa System	14,497.49
Central Ontario & Trent System	2,539,212.44
Nipissing	182,415.74
Bonnechere Storage	13,774.82
Service buildings and Equipment	499,137.91
Hydro-Electric Railways	140,803.90
Insurance–Workmen's Compen't'n & Staff Pension Insurance	2,156,246.41
TOTAL Reserves of Commission	$37,545,583.86

It is interesting to note the very rapid increase that has taken place during recent years in the reserves of the co-operative municipal undertaking administered by the Commission.

Details of the activities of the Commission are given in the Annual Report for the year 1928 of the Commission. The following brief facts will be of interest in respect to the operations of what to-day is believed to be the largest hydro-electric enterprise in the world.

In order to clearly understand the financial condition of the entire undertaking, it is necessary to include the reserves of the Municipal Systems along with the reserves set up by the Commission. In 1918 the reserves, including the reserves of the local Hydro Utilities, aggregated $11,446,889.16; and in 1928, these reserves had amounted to $75,545,583.86; an increase in the ten year period of $64,098,694.70, or more than 560 per cent.

Some conception of the growth that has taken place in all branches of the Commission's activities may be gathered by citing a few comparable figures relating to the capital expenditures, reserves, loads and rural work that has taken place during the last decade; for example, in 1918, the Commission's expenditure amounted to approximately, $61,000,000.00; to-day it is over $211,000,000.00.

In 1918, the investment of the Municipalities was approximately, $27,000,000.00 and to-day it is over $89,000,000.00.

In 1918 the aggregate investment in plants and assets in the undertaking was $88,000,000.00, and to-day it is over $300,000,000.00.

In 1918 the total reserves were $11,500,000.00 and to-day they aggregate $75,500,000.00.

In 1918 the total load supplied by the Commission was approximately 317,000 horsepower and to-day it is approximately 1,071,000 horsepower.

In 1922 there were 320 miles of rural lines constructed and to-day there are 4,103 miles.

In 1922 the Commission supplied 2,226 rural consumers and to-day they are supplying 31,068 consumers.

In 1922 the load supplied to rural consumers was 393 horsepower and to-day it is approximately 17,000 horsepower.

In 1922 the total expenditure for rural lines and equipment was

$681,891.49 and to-day it is $8,951,779.14.

It will be interesting to note that as late as 1925 the annual increase in the Power Systems' Reserves of the Commission was about $3,500,000.00. Last year the increase was $6,300,000. after the Commission had paid to the Province $1,600,000.00, out of reserves, thereby placing the Commission in the very satisfactory position of not owing the Government a single dollar other than loans on capital account which are being paid off by sinking fund as provided by law.

With like annual contributions to the reserves of the Commission with interest at 4 per cent., taking no account of augmented power revenues, it is estimated that the reserves of the Commission will exceed the present capital expenditure of $211,000,000.00 in a period of fifteen years.

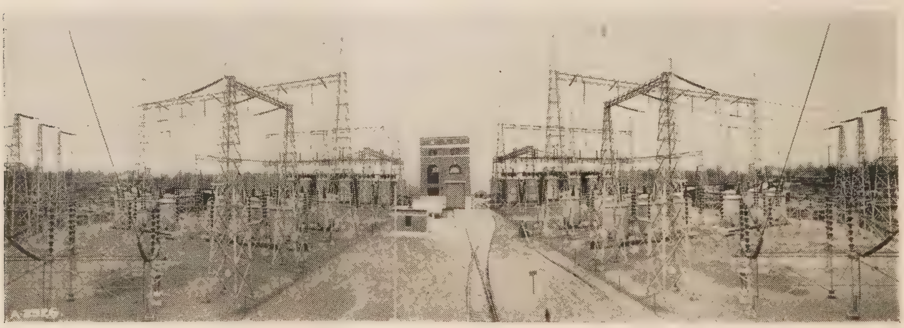
Exterior Lighting, Toronto-Leaside Transformer Station

THE property comprises an area of about 12½ acres of which a considerable proportion will ultimately be occupied by outdoor switching, equipment and structures.

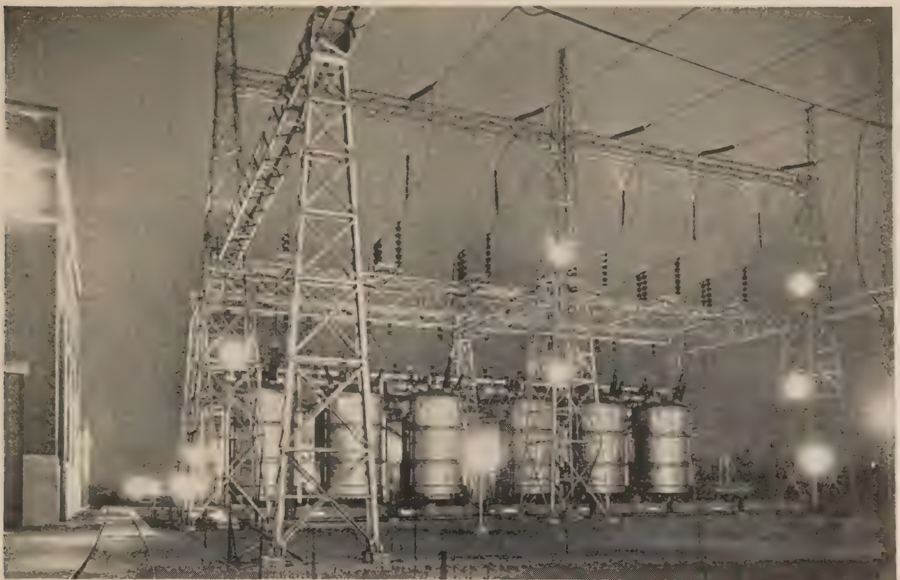
Such an extensive outdoor switching station required adequate lighting for night operation and inspection. Systems of floodlighting were investigated but were considered inadequate for such a large switching station due to presence of harsh shadows and glaring light sources.

To avoid the inherent weaknesses of floodlighting equipment for this service a comparatively new method of lighting was proposed and finally adopted. Briefly it consists of prismatic glass street lighting units modified in detail for use in an inverted position so as to project practically all the light emitted from the lamp above the horizontal plane.

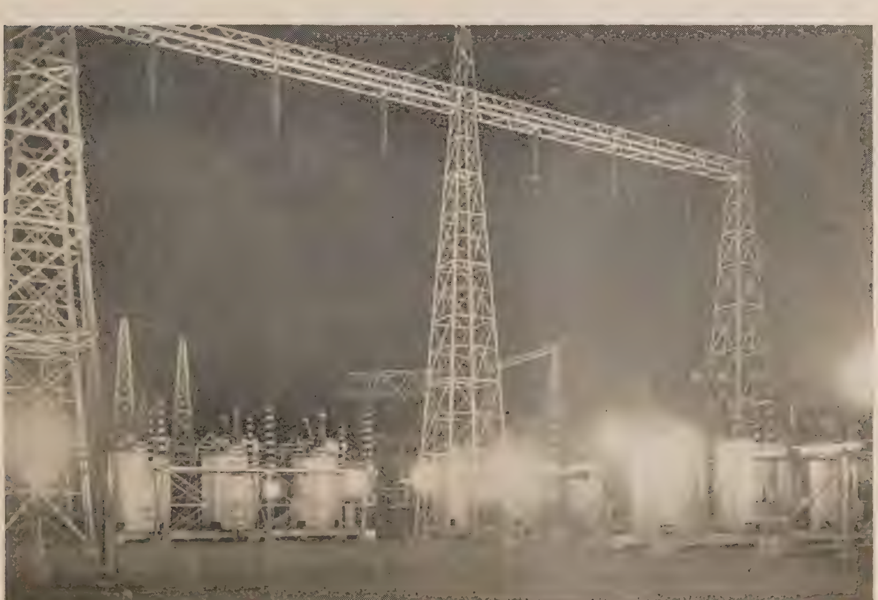
The accompanying reproductions of un-retouched photographs taken at night show the results. One view looking south shows a part of



Toronto-Leaside Station as it will appear when completed.



Toronto-Leaside Transformer Station, 220,000 volt Transformer Bank at night



Toronto-Leaside Transformer Station, 220,000 volt Oil Breakers at night

the 220 kv. structure and two transformer banks with the service building at the extreme left. The other view is looking north and shows the supporting towers, 220 kv. oil circuit breakers and the incoming line dead-end tower in the centre background.

Status of Lightning Surge Investigations in the United States

By Everet S. Lee, General Engineering Laboratory, General Electric Company, Schenectady, N.Y.

(Address before Association of Municipal Electrical Utilities at Toronto, January 23, 1929)

WE regret that sickness has prevented both Mr. Towne and Mr. McEachron from being present to address you on the subject of G-E. Pellet Type Lightning Arresters. In their place I will speak to you for a few minutes on the present status of lightning investigations and studies of protection from lightning, as applied to overhead transmission lines in the United States. In bringing you a present picture of this situation I recognize my inability to make it complete in all details because of its extent, but I will endeavour to bring to you a general statement with such details added as are familiar to me and to which other details may be added as they become known. The work is of a research character and will, no doubt, appeal to you in connection with possibilities for similar work in your own country.

A most important factor in the design and operation of transmission systems is a knowledge of the characteristics of the surge voltages on the lines due to lightning. Until about five years ago the only device generally available for determining these was the sphere-spark gap, for which purpose it was quite limited in that it produced an indication which only said that the crest value of the voltage was at least the indicated value. This was helpful and allowed conclusions of value to be drawn from the results obtained therewith, but it was not totally sufficient.

The difficulties attendant to line studies, therefore, caused the investigators to turn to the laboratory, where extensive investigations were carried on by the manufacturer of transmission system equipment in which the operating engineer cooperated. Giant lightning generators were built; a model village was constructed with houses, churches, and transmission lines; and the artificial bolts of the lightning generator were trained upon it. The characteristics of the lightning generator being known, the effect produced could be ascertained. Thus the principles of lightning protection were studied.

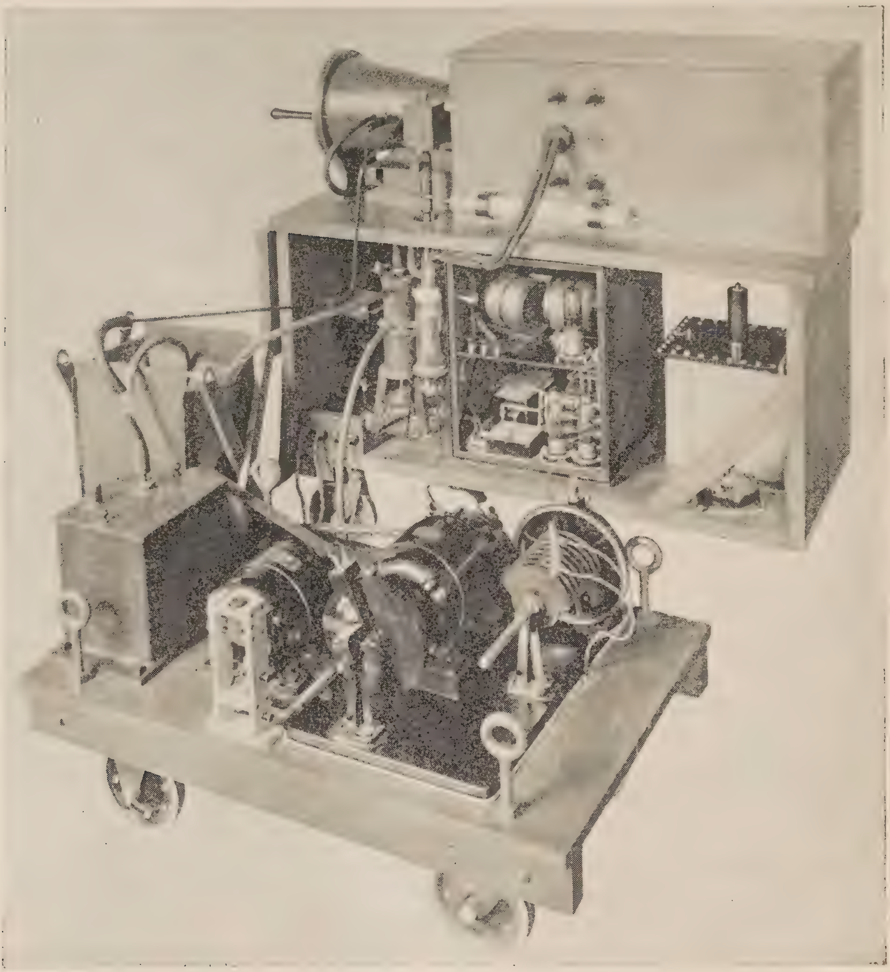
The contribution of Mr. Peters of four years ago in giving to the art

of electrical measurements the idea of utilizing photographic Lichtenberg figures for measuring surge voltages was an advance over the use of the sphere-spark gap for this purpose and gave an opportunity for measuring the characteristics of surge voltages existing on the transmission lines with more completeness. The characteristics of the instruments using the photographic Lichtenberg figures were studied in the laboratory using the lightning generator, sphere-spark gap, and cathode-ray oscillograph. It was found that the crest value, polarity, and time of occurrence of surge voltages could be measured quite satisfactorily. The records were not so definite with respect to wave front and nature. They gave no knowledge as to wave tail. It was thus early recognized that the cathode-ray oscillograph would have to be made available for measurements out on the lines to give an exact photograph of the wave form of the surge voltage. This has now been done and this summer the first photograph of a surge voltage due to lightning on a high-tension transmission line in this country was recorded with a G-E. Cathode-Ray Oscillograph. Thus the knowledge gained in the past from the use of the lightning generator in the laboratory is now being extended by measurements made in the field where natural lightning is the source.

This is a most fortunate situation for it has brought the operating engineer and the manufacturer together to advance their knowledge of transmission system performance. Together they have gathered the data from the field; together they have tabulated it; together they have interpreted it. And with this cooperation has come a clearer understanding of the problem, with a better appreciation on the part of both of the individual problems of each, one in making transmission system equipment, the other in using it .

It is this particularly recent activity wherein the measurements are being made directly on the high-tension transmission systems that I bring to your attention. Although all the information from this work is not totally available, published reports, together with other knowledge, indicate that measurements have at one time or another been made on some fifty high-tension systems in the United States including both underground and overhead lines. Two electrical manufacturers have cooperated independently with the operators of these systems in this work, and the colleges have contributed in some cases. A low estimate of the total expenditure for their activities is a quarter of a millon dollars.

What are the usable results of this work to date? It was found very early that surge voltages due to lightning did not exist on underground cable lines in magnitude to be harmful. Investigations on these systems were therefore largely discontinued. It was also found that there were territories in which apparently such lightning as existed did not affect transmission system operation adversely. Investigations have been largely discontinued on these lines. But it was also found that the operation of certain transmission



Cathode Ray Oscillograph

systems were adversely affected by lightning, and on these systems the investigations have largely been continued.

The idea of a continued investigation on a system has been found to have much merit. The conditions observed one year do not reappear uniformly in succeeding years. The accumulation of additional data gives greater certainty to the conclusions and shows us more clearly what we know and what we do not know. Measuring technique is improved.

It is most gratifying that these principles are recognized by those directing these investigations and providing for their continuance, for it assures us that the problem will be properly solved.

The results already attained have contributed substantially to our knowledge of the characteristics of surge voltages existing on

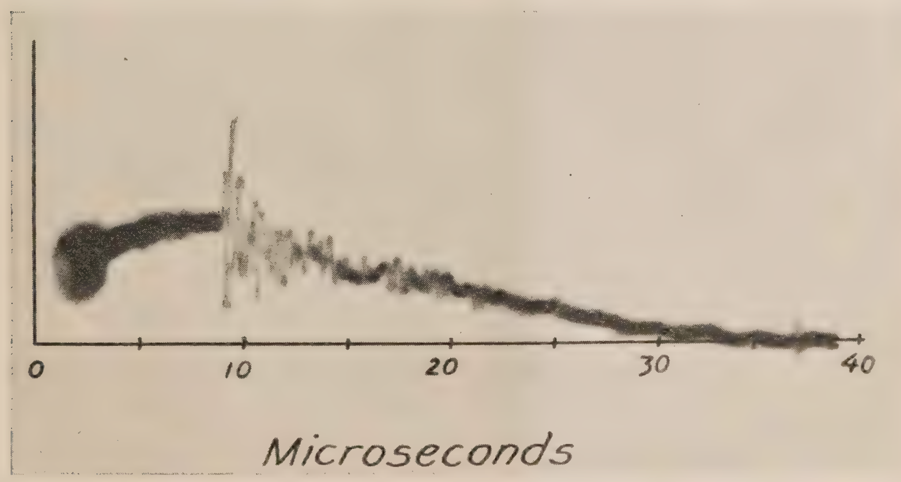
transmission lines with respect to their peak value, wave form, polarity, attenuation, and frequency of occurrence. While it is recognized that these characteristics have not been definitely established, there is sufficient data available from which their order of magnitude can be stated with reasonable exactness.

The crest value of major surge voltages due to lightning is from 7 to 15 times normal peak voltage to ground. The fastest of these attain their peak value in less than 10 millionths of a second. They are of both negative and positive polarity, though the greater number are negative. They are unidirectional or oscillatory and if oscillatory are damped out in a few cycles such as five. They decrease quite rapidly in peak value in traveling along the line, those of highest initial value decreasing to one-quarter of their initial value within 10 miles. Usually there are not more than one or two surges of high value per storm. Invariably they cause automatic switch tripouts.

On one isolated neutral system surge voltages of moderate crest value were found which extended throughout the system. These have been attributed to oscillations following flashover between line conductor and ground.

With the lightning studies, the characteristics of surge voltages due to switching have been obtained. In general, these are from two to five times normal peak voltage to ground in value. They invariably extend throughout the system.

These results were obtained with instruments known as klydonographs and surge voltage recorders, and the cathode-ray oscillograph. The former of these utilize the photographic Lichtenberg figure produced when a surge voltage is impressed upon an electrode bearing upon a photographic film. In these instruments the film is about 8 inches wide and 8 feet long, driven by a clock at a speed of ½ in. per hour to give a continuous film record for one week, after which the film must be changed. The



First Cathode Ray Oscillogram of Lightning Surge on Transmission Line

record is in the form of a radial figure of distinctive pattern, the diameter of which is a measure of the surge voltage. The figure becomes visible upon development of the film. The klydonograph has one electrode per element and the figures formed include both the positive and negative polarity characteristics of the surge. The surge voltage recorder has two electrodes per element to enable the positive and negative characteristics of the surge to be ascertained with greater exactness. This is the fundamental difference between these instruments.

These instruments are easily portable and being self-contained may be located at any point along the line. For such installations the instrument is enclosed in a sheet metal housing for protection from the weather and for electrostatic shielding. The instrument being suitable for measuring surge voltages directly only in the range from 2.8 kv. to about 25 kv. it is necessary to connect it to the transmission line through a suitable potentiometer. These have been constructed and used in a variety of forms. Electrostatic potentiometers with air dielectric have been used to advantage. A potentiometer consisting of a string of line insulators connected between conductor and ground with an instrument tap near to the ground end has proved to be a most convenient, inexpensive, and simple form for use, especially when there are many installations on a system. Extended use of the insulator string potentiometer has proved its worth, and tests both in the laboratory and field have proved its accuracy. It was found, however, that stray figures resulted on the films at various times which were thought to be due to alternating voltage of normal line frequency of relatively long duration, such as up to a minute. The use of simple grading rings at the top and bottom of the insulator string has eliminated this condition. Hence the insulator string potentiometer with grading rings may be safely used.

The calibration of the instrument and the determination of the potentiometer ratio is made in the laboratory using a lightning generator, and an identical field set-up. Such calibrations are comparatively simple to make in the lower voltage ranges, such as up to 500,000 volts, but at higher values they are more difficult. Calibrations have been made up to 1,500,000 volts and these will shortly be extended up to 3,000,000 volts to provide accurate calibration data for the voltages which are being measured in this order of crest voltage. It is this work which keeps the laboratory busy in connection with the field investigations making imperative the availability of the lightning generator and cathode-ray oscillograph for such.

At the end of each week the films from all the instruments on a system are correlated, and surge voltage records occuring at the same time on different instruments are grouped together as one surge. This is then correlated with any operating or weather data available. Surge voltages of high peak value occurring during storms are attributed to lightning though the definite presence of lightning is only known in a few cases. Automatic switch tripouts

practically always correlate with a surge voltage of high crest value. The insulator flashovers, as determined from line inspections, are, however, usually several times greater than the number of surge voltages of high value.

The earliest installations consisted of a few instruments per system, such as from 2 to 10. As data was gathered from these there was a recognition that more instruments on the same line were desirable to increase the chances of measuring the highest value of the surge, and to be able to draw a profile of the surge more completely. This idea has found much favour and has been extended until today there are systems under study wherein 40 and 50 instruments are in simultaneous use. With proper supervision of these, the operating performance of the instruments is maintained at high values, such as 90 per cent. which is considered to be quite satisfactory under the conditions.

By studying the crest value of the voltages recorded at the different stations along the line for any one surge, an idea of the attenuation may be obtained. It has been found that the high surge voltages due to lightning decrease in magnitude quite rapidly. For example, a surge voltage showing a maximum value of 2,000,000 volts has decreased to a quarter of this value within 10 miles. From such data a formula has been derived which involves voltage and distance. From the formula the peak voltage of the surge varies inversely as the distance and the decrease in peak value varies as the square of the voltage. Since the decrease depends upon resistance loss in the conductor and corona loss, and since it is known that resistance loss accounts for only a small amount of the decrease, the greater part of it must be due to corona loss. Corona loss varies as the square of the voltage so that the decrease as shown by the formula seems to tie in with corona loss. There are doubtless other factors which enter. A factor k in the formula probably includes these. From the data gathered there is some doubt that all readings attributed to the same surge can be of the same surge. Possibly they represent two or three surges. This is still a disputed point in some quarters and will have to be decided by future work. The speaker is one of those who believe that attenuation data of great value can be obtained from records such as described.

In addition to the magnitude of surge voltages, it is necessary to know the wave form, since insulation breakdown depends not only on the peak value of the applied potential but also upon the duration of the highest part of the wave. For this information the photographic Lichtenberg figures are not so definite. One study of 154 figures led to the following very rough summary as to the duration of wave front: about 20 per cent. were between 1 and 10 millionths of a second, about 20 per cent. between 10 and 100 millionths of a second, and about 60 per cent. over 100 millionths of a second. Special set-ups using several surge voltage recorders with various time delays gave results to indicate that the wave fronts measured were less

than 20 millionths of a second. The one surge photographed by the cathode-ray oscillograph showed that the surge rose practically to its maximum value in 5 microseconds, decreased to half value in 20 microseconds, and reached zero in 40 microseconds. This surge was of positive polarity and was unidirectional. Further use of the cathode-ray oscillograph should allow us to settle definitely the question of the wave form of the surge voltages.

In a paper entitled "Lightning" to be given by Mr. F. W. Peek Jr. at the coming Winter Convention, A.I.E.E., in New York, this surge is shown to be exactly similar in form to one used by Mr. Peek in his laboratory for studying the effects of lightning. Thus the work of the laboratory and field is definitely correlated.

With installations of instruments such as these described, studies have been made relative to the effectiveness of the ground wire as a protector against lightning. A conclusive study is very difficult to make as it is almost impossible to obtain two lines of identical arrangement in identical territory subject to the same lightning conditions, and one with and one without a ground wire. Studies made to date have shown the benefit due to overhead ground wire in some cases to be very small and in other cases to be almost up to the theoretical value.

The opportunity to observe the effect of choke coils and the operation of lightning arresters is not being neglected, though there is the same difficulty here as with the ground wire, for the effects with and without lightning arresters cannot be measured. Mr. McEachron has a better set-up for measurements such as these for he has constructed a portable lightning generator for half a million volts which he can take out along a transmission line and impress surge voltage of different wave forms at will. Cathode-ray oscillographs on the line record the wave form. In this way the performance of lightning arresters as in service can be accurately ascertained. Mr. Eachron will present some results from his work at the Regional Meeting, A.I.E.E., Cincinnati, Ohio, March 20-22.

I have thus far presented a picture to you which shows the operator and the manufacturer cooperating to answer the question as to the characteristics of surge voltages on transmission lines. Instruments using photographic Lichtenberg figures are available as voltmeters for connection to the line at desired points. The cathode-ray oscillograph is available for photographing the wave form of these voltages. The extensive use of the former of these in the past few years, and of the cathode-ray oscillograph in the past year, has resulted in new knowledge as to the characteristics of the surge voltages existing on the lines to the extent that these characteristics can be stated quite definitely in terms of measurable quantities. The availability of the instruments for measuring these voltages makes possible independent measurements on transmission lines by the operator as he may desire. In addition the picture must include extensive laboratory work carried on in parallel with the

field work as the latter has unfolded usable results.

In looking at this picture you undoubtedly see many details yet to be supplied. I have not painted into it the troubles experienced in bringing these measurements to their present status. Troubles are but relative and in making these measurements they have been looked upon as obstacles to be overcome. Many of them have been overcome. Others yet with us are known or are surmised and are being studied. Chief among the present difficulties are the inability to distinguish between the records produced by direct and induced strokes, and the inability to ascertain with exactness the location of the lightning stroke. Apparent inconsistencies exist in some records. These show us that something is present concerning which we do not know and that search must be made for the answer. The technique of the measurements must constantly be improved towards greater simplicity and certainty. These advances will come with continued work upon the problem.

The data gathered thus far is from present existing lines, and as such is of use in throwing light on the reason for present transmission system performance with respect to apparatus failures and line tripouts. To be of value in projected design of transmission systems it must be considerably augmented. This brings us to the work of the future. In this we are directed by the work of the past. Any suggested test program that involves using the lightning as the source should be carefully considered. One of the greatest difficulties in making measurements on the lines is the uncertainty of the occurrence of the lightning. It can neither be controlled nor predicted within satisfactory limits. This means that large investments of measuring equipment and high expenditure for personnel are involved while these wait for the lightning which the operator of the transmission line hopes will never come, except as his interest in the advancement of the art overcomes his enthusiasm for rendering continuity of service for the time being. Then when the lightning does come, no one knows from whence it came nor whither it went nor how much it was. Such is not a satisfactory situation scientifically.

The calibration of the present transmission lines in terms of the effect of lightning upon them now allows us to apply lightning generators to the lines to duplicate these effects. In this way equipment will be established whereby present and projected transmission system design can be tested in the field with comparative rapidity, certainty, and satisfaction, and means for protecting transmission systems as may be evolved can be tried out. The construction of lightning generators and the operating technique in connection with these has advanced to where this is a feasible suggestion; Mr. McEachron is now doing it. It is the logical second step now that the characteristics of the surge voltages on the lines have been ascertained with sufficient exactness to assure that the lightning generator is duplicating the lightning. This is again a case of extending the work of the laboratory into the field, since having ascertained from

the field the line conditions as regards surges, these have been for the past years duplicated in the laboratory and used to test transformers, insulators, and transmission lines, and to study their performance. Thus the work in the field and factory progress together.

In parallel with this extension of work involving the surge voltages on the lines, studies should be undertaken to learn more about the lightning itself and how it gives rise to these voltages. This involves the development of instruments for measuring the intensity of lightning, for ascertaining the magnitude and nature of the bound charge, and the mechanism by which the lightning releases the charge to result in a traveling wave. Until our knowledge of the source of our troubles is advanced so that we can speak of lightning and its action in terms of definite values of measurable quantities, our knowledge of it will be too meager to allow us to effectively fortify our transmission systems against it.

How may these objectives best be accomplished? The interest of the manufacturer and operator during the past few years has been most keen in the solution of this problem. Much money has been spent from which some definitely usable results have been obtained, from which a measuring technique has been established and is being improved, and from which a personnel has been trained in the art. A continuance of this work by these agencies means definite progress.

Discussion

Mr. E. V. Buchanan, London: I am glad Mr. Lee presented this paper immediately following my remarks about research, because it rather stresses my point. I believe that our conditions in Ontario with regard to lightning are more severe than in most parts of the United States. I have been told by some of the engineers of the Commission that lightning conditions are most frequent and severe in this part of the Province. I do not know whether they have any Lichtenberg charts in the Laboratories, but I think they ought to have. They have just constructed the 220 kilovolt line between Toronto and Ottawa, and I know that on similar lines in California, during the past five years, they have had a great deal of trouble. The Commission has benefited to a great extent by the trouble on those lines, and at the same time I think they know the trouble they are up against in connection with local conditions. Investigation should be made into those conditions along the line suggested by Mr. Lee. The only other thing I have to say is Mr. Lee did not get results that would entirely condemn the ground wire which I think is a nuisance.

Mr. G. D. Floyd, H.E.P.C. of Ont. The question of lightning is apparently being given a great deal of thought at the present time, and a great deal of investigation work is being done to settle many of the controversial points that have come up regarding it

The results of the work that is being done are being discussed at the Winter Convention next week in New York, I believe, and an endeavour is being made to co-relate all the information.

There are a few questions I wanted to ask Mr. Lee. The first one concerns flash-overs. He stated that the impulse ratio over a string of insulators was in the neighborhood of two. Now I understand that that is for a flash-over along the string of insulators. I would like to know if there is any modification in this factor if the flash-over takes place between the line end of the string and the tower. The next question is regarding the lightning flash-over on wood pole lines. Most of the investigations apparently have been made on steel tower lines. I should be very much interested to know if Mr. Lee could give us any information on what the impulse ratio, for instance, is on a wood pole line. The third question was a statement he made regarding the time to reach the crest value for a large number of surges that had been studied. I think he said Mr. McEachron had stated that 20 per cent. of the surges were from one to ten micro-seconds and another 20 per cent. were from ten to one hundred micro-seconds. I would like to know where the surges of the highest crest value came in the list that was made.

Mr. Lee: I am afraid I cannot answer any of the questions completely. There is a long story about all of them. As regards these analyses, I do not remember where the maximum came. I just wanted to say that we felt all the time that our results from the Lichtenberg figures were somewhat uncertain. I gave the data obtained from a crude way of measuring and followed by a better way which showed to a very large extent what the crude method gave, and was a more accurate method and the better way of measuring. Regarding the wood pole line, the Companies in the United States have spent a great deal of money in having tests made in laboratories to determine those characteristics, and it is because they have paid for these tests that we are unable to give out the results of the tests which were made in the laboratories and that is probably why they are not reported. I do not carry the results in my head. I could not tell you them anyway and that is probably why you have not heard more about it. With regard to the flash-over that ratio is along the string of insulators.

Suggestions for Electrical Development

By K. A. McIntyre, Managing Director, Society for Electrical Development, Inc., New York.

(Address before Association of Municipal Electrical Utilities at Toronto, January 24, 1929)

LESS than a year ago, our S.E.D. staff made an extensive study of what the electrical industries were doing in respect to organizing to compete against other industries in selling the ultimate consumer. In the course of this study, we became acquainted with the work of one hundred and nine different Associations in all lines of business, which Associations are actively carrying on extensive programmes of co-operative market development. Some of these programmes have been classified and grouped in terms of the items of the consumers' budget, showing the money being devoted to arousing consumers' interests. Most of these one hundred and nine organizations operate internationally, as far as Canada and the United States are concerned, and in 1927 spent nineteen million dollars in market development work of this kind. This is the competition that our electrical industry must compete with.

To get an idea of what the budgets of these organizations are in terms of the volume of business done by each industry. You know that paint and varnish has been doing a great job for its industry. "Save the surface and you save all". They have an annual volume of business of three hundred and seventy-five million, and they are spendng two hundred thousand a year to get that idea over. The Copper and Brass Research have been doing the same thing, popularizing the use of copper and brass in many, many ways; an annual volume of two hundred and fifty million, and devoting four hundred and fifty thousand a year to commercial research for the whole industry and to market development. The Portland Cement Association is the best organization of its kind, with four hundred million dollars per annum, and devoting one million dollars of that annually to the work of getting the concrete idea over. The closest figures we have to our electrical industry are nine hundred dealers in the residential field, and the S.E.D. last year had $191,000.00 to spend. That gives an idea of how we are heading. The condition several years ago, was a variety of electrical Associations with no co-ordination or tie in between them and a whole lot of duplication. That condition continued until a little over a year ago. At that time, owing to financial and industrial reasons, an interest was taken in the Society and theoretically at least it was put on its feet. It has a Board of Directors, and they have now tied together the several Associations. The local Leagues are represented on the Society's Board. It so happens that Mr. E. M. Ashworth

is a member of the League Council, representing the local Electrical Leagues of the United States and Canada, and is a member of the Board of Directors representing these Leagues. There is a set-up of Advisory Committees, one for each of the major activities, for instance, the Red Seal and so on, and then the staff of the Society operates under the direction of the Board and Officers. So there is provided here an interchange of information, experience, and a direction and control which practically eliminates the duplication of effort in Association work.

A word or two about the S.E.D. staff as it operates to-day. In the middle of the last year, we reached a point where the staff itself was reorganized and departmentized, and we are now well set in that respect.

An interesting feature on the inside is that they are all endeavouring to make this intangible work just as tangible and concrete as possible. Each of these operating departments makes out monthly a comprehensive report of its doings. They are consolidated and supplemented by the report of the Managing Directors preceding the others and including all our operating and financial statements for the month and a complete set of the operating reports goes to the officers of the Society and to the officers of the several national Associations. They know exactly what is going on every month; and that goes for Red Seal and every activity that we have.

The first practical work the Society took on many years ago, was that of newspaper publicity dealing only with popularizing electrical uses, the present time, nine hundred and eighty-four newspapers are served weekly in the United States and Canada. It is propaganda, but propaganda of a very high order. No commercialism enters into it. It is all informative, and in the consumers' interest, along with which goes a monthly advertising service for the central stations, with twelve or thirteen advertisements in mat form, with suggestive copy each month; a very handy thing for these central stations that are active in merchandising, and most of them are.

Many of you are familiar with the *League and Field Services,* which operate this department and which is bringing together, locally or territorially or regionally, the different groups of the industry in well organized Electrical Leagues. It will interest you to know that in 1922 there were five Electrical Leagues, four in the United States and one in Canada, (located in Vancouver), that employed staffs. To-day, there are forty-two organizations in the United States and Canada, local in their operations and doing this kind of work. The leaders of the Society about that time came to the philosophy that you cannot get anywhere with national work without Committees that if large scale results are to be accomplished, there must be intensive co-operation in the locality itself, and all the International Organization can do is to give a certain amount of leadership and to serve as a clearing-house to distribute a certain amount of inspiration. That is the way this Society has functioned in the last seven years; and it was directly due to this work that I

suppose ninety per cent. of the Leagues now in existence have been organized. In 1928, our field staff made one hundred and ninety-six visits to different Cities and travelled ninety-five thousand miles in connection with the field work itself. In addition to that, we got out a printed monthly bulletin, which goes to all the Leagues and members of the Society too. That is the house organ of the local Electrical Leagues of the United States and Canada, more than forty-two of the number operating year in and out with paid staffs. Their total budget for 1929 involved something over $800,000.00. Some years ago, in connection with the local co-operative work, there was started annual conferences bringing together representatives of these local co-operative Associations at Association Island, in Lake Ontario. At the last one, last August, there was a six-day business programme and two hundred and thirty in attendance representing forty Leagues and seven national Associations. Last year, this work had grown to the point where it was advisable and desirable to institute the mid-Winter Conferences, just as you find it is advisable to have two a year, and we have just had in Cleveland the week before last a three-day business programme of well organized but informal round table discussion; a total registration of 101, with 39 Leagues represented, and so full of meat and experience of this kind of specialized work that the delegates who were present were high in their praise of the value of the conference. I think those who attend these League Conferences represent a very large share of the highest order of League business.

You are all familiar with *Red Seal* which came out of Toronto, and it came out of Toronto because Toronto at that time got the electric home from somewhere else and cast its bread on the waters. Inspired by Toronto's example and initiative in developing this most practical of all activities in getting actual results, this work has become national in the United States and there are forty-six Leagues operating, and the last figure I had on Red Seal homes is fifteen thousand in the United States. Of course, the results this industry gets and the convenience the consumer gets out of this educational effort is not measured by the number of homes you have got. The influence of selling is extended over many homes that are equipped with the actual Red Seal standard, but generally the wiring standard is substantially raised. There is nothing more definite in terms of results and co-operative activity than that.

The matter of getting uniform ordinances for regulation of wiring in Ontario has been solved, but it is an important department in the United States. That work has to be done with the municipalities themselves.

The promotion of the *electric sign business*, is a specialized activity, supported by manufacturers of electric signs and lighting products, doing a very good job: I attended a meeting of this group in Chicago yesterday. They approved next year's budget for an extended programme, but those of you who are interested in the electric sign business

can, without any obligation, get pretty good information, on how to go about it. There is an electrical school going on in Chicago today, which is to last for four days, with one hundred and seventy-five men in attendance, learning how to promote the electric sign business.

Christmas Outdoor Lighting:

You have not seen so much of this in Toronto. You have undertaken it in a modest way, but you can have no idea of the scenic effect that is being had as the result of this activity in the United States, the stimulation of a great amount of interest, some Cities having as many as ten thousand homes decorated with outdoor decorations at Christmas time. In the City of Minneapolis, which is smaller than Toronto, it took twenty-one teams of two men each several evenings to cruise around that City and judge the entrants, and to go through the elimination process in the awarding to these prizes. The Society offered some national prizes on behalf of the manufacturers last Christmas, and this aroused a great deal more interest. It is an easy thing to organize and has a very good effect. You have no idea what elaborate displays are put in where people really get the competitive spirit in fixing up their houses outside at Christmas time.

There has now been developed a companion business to Red Seal in the form of a national standard in the United States for commercial and industrial lighting applications. The specification was released within the last thirty days. The proper authorities have agreed to a specification which sets forth a minimum recommended standard for commercial and industrial lighting installations of various types, with the system available to all electrical Leagues, in the same way as the Red Seal on house wiring, for making an award to the installation that measures up to these industrial standards. An emblem has been designed so as to bring the Red Seal standard into the emblem, and this is going to be the common denominator of all Red Seal applications of this kind, and I think it will eventually extend to the wiring of commercial and industrial buildings, which situation is in quite a deplorable state everywhere. This is a very recent development, coming out of Chicago,—who took the good idea out of Toronto and gave it in turn to the whole industry. We are getting requests for instruction how to operate on this from a number of countries throughout the world.

A New Development: I heard research mentioned here to-day. One would expect the Society for electrical development, standing for what it does, to have a research department and this was instituted last Spring. In this department is gathered together all the information that we can get that will be useful, and also in this department are conducted studies such as I referred to before in going over the activities of other industries. In addition to that, all new projects are developed through this department. In this last year, there was developed a plan book of selling the idea of electrical refrigeration, and another plan book with printed promotional material on selling the idea of electric cookery,

with some very fine printed material, in several colours, in it. Just recently, I got the latest figures we could get at as to employees of the several branches of the industry and these figures are as follows in the United States: Central station, 290,000 out of a total of 940,000. This 940,000 into eighteen million residential customers gives one electrical industry employee to each twenty residential customers; quite an opportunity for influencing the public mind in the direction of more use in electricity and getting more benefit out of electricity. Of course there is a concentration in manufacturing centres, in jobbing centres and so on, but it gives us the idea of the potentiality through selling our own electrical industry people. That job has not even been begun. I feel that the biggest thing this co-operative work does is the influence that it exercises on the thinking men of the industry who are connected with this movement. There is no estimated value of that or the possible new ideas that may come out of that kind of thinking. The important thing to keep in mind is the fact that approximately to four central station or public utility employees, there are nine other employees in other branches of the industry, so that it is a good thing, from the central station point of view, to build up continual co-operation with the other branches of the industry.

I referred to the study that had been made of these other industries. That was preliminary to engaging a professional concern for devising a sales plan for the electrical industry. It has been realized for some years that millions of residential consumers have been connected to lines over the past twenty, thirty or more years, and that the wiring which went into those homes at the time, under pressure of desire to get them to connect it, is hopelessly inadequate. It was the desire to find just exactly what the condition was, what the state of mind of the consumer was in regard to this, and what kind of effective plan might be devised for correcting this condition of inadequate wiring. The J. Walter Thomson Company of New York, Chicago, San Francisco, London, and a couple of dozen other places around the world, was selected after very careful elimination. They have been at work since May 31st. In the course of some months, they made a full study of twenty cities in the United States and Canada, from coast to coast, and almost to the Gulf, including Toronto. This field study was brought through in December with a report of the conditions found; and a proposed plan for selling, that has been going through the mill, is being subjected to the acid test. There have been two Directors' meetings of the S.E.D., one in December and one in January, to receive and deal with the report, and a Special Committee has been appointed to go into it further, and will meet next Thursday and Friday in New York. The investigation thus far is confidential, but I think it is all right to refer to one fact and that is that 70 per cent. of the women interviewed stated that they felt no particular interest in improving the wiring in their homes. Wiring, of course, is

only a means to an end; but the seventy per cent. figure clearly shows that the electrical industry has been away behind in its efforts to arouse a realization of how important it is that the copper wires be free and large enough to carry the flow of electricity that they need.

In conclusion, I feel that in trying to localize the talk to Ontario, as I have had an opportunity for some seven and more years to observe both sides of the line, from the Pacific and the Atlantic, in the low rate territories there is a tendency to concentrate all effort on ranges and water heaters and to sit back comfortably when a reasonably high degree of saturation has been reached thinking the job has been done. I have had no chance recently to look personally into the situation in Ontario homes; but within the last couple of years, I did personally go from house to house in new building construction in Winnipeg in connection with their consideration of Red Seal, and I found that, as to ranges and water heaters, they were fine, but as to convenience outlets for the other things which are quite essential and perhaps much more labour saving in their effect, the provision was away, away below anything that ought to be. A survey showed that in twenty cities, which included old homes in Toronto, only 1.9 per cent. of over 3,000 houses were wired up to the minimum red seal basis. Now, in Winnipeg, you will be glad to know they have just decided to go ahead with Red Seal in spite of the fact that they possess one of the highest saturation points in percentage on ranges and water heaters of any city in the world. They have raised a budget of some ten thousand dollars. I believe they have the cash in the bank, and they have employed their manager and he is coming down here to Toronto to study Red Seal at first hand. I know right here in this city, some six years ago when I went out on a test trip to call on builders, I talked to one builder who was putting up one hundred houses in one portion for sale speculatively, and he just laughed at me when I tried to sell him the idea of putting in a range capacity service. Red Seal, in this City to-day, has got control of the new building situation because 80 per cent. of the buildings last year were wired up to Red Seal standards, and that means not a cent of expense for putting in ranges and water heaters is involved by the owner or tenant, and I am certain, that there is no city in Ontario or the rest of the country that can show any such record. Now that has been done only by a lot of work and by giving attention to the problem. But ranges and waterheaters are not the only thing, and we should give attention particularly to adequate provision for other useful electrical things that ought to be in every household.

I think we in the electrical industry —and particularly in the public utility end of it—owe an obligation to a customer in his and her interest to give attention to this very problem. They do not realize it until they are informed. They build a house or buy a house and do not know it until too late, and unless the electrical industry in this way gives attention

to this problem, the consumers' interest will continue to suffer.

The development of the merchandising business has to do with the appliances, yes; but there are other phases. There is lighting and there is the getting of adequate wiring on to these jobs. My suggestion, in concluding this informal report, is that you take this thing into serious consideration and take such action as you see fit; that you deal with this in the way of getting organized action, and I think a whole lot of good can be done if you do so.

Insurance and Superannuation Plan for Municipal Commission Employees

By Hon. I. B. Lucas, General Solicitor, H.E.P.C. of Ont.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities at Toronto, January 24, 1929)

MR. MACINTYRE yesterday suggested that I should attend your meeting today for the purpose of giving some explanation of the proposed scheme for insurance and superannuation allowances to employees of the various municipal commissions throughout the Province.

In compliance with that request I am here to briefly outline the scheme and the progress that has been made towards bringing it into effect. First then the History!

Some two years or more ago this Association passed a resolution requesting as I recollect, the Ontario Commission to investigate the best method of bringing into force an insurance and pension scheme for the benefit of the employees of the municipal commissions, and my recollection is that the resolution suggested that the scheme might follow the same general lines as that covering employees of the Ontario Commission.

This was followed up by a committee representing your Association at a conference with the Government requesting the necessary legislation to authorize action, with the result that what is now "The Power Commission Insurance Act, R.S.O. 1927 Chapter 60" was passed by the Legislature.

This Act authorizes the Commission to enter into an agreement with any municipal hydro commission to contract with an insurance company on behalf of the local commissions for death benefits and superannuation allowances to the employees of such commissions, and it further authorizes the Commission, with the approval of the Lieutenant-Governor in Council to enter into an agreement with an insurance company for providing the benefits above referred to.

In short, the legislation authorizes the Ontario Commission, on behalf of local commissions, to take out the necessary insurance policy.

Your Association then named a large committee, representative of the municipal commissions, for the

purpose of investigating and finally reporting on and recommending some scheme or type of policy for adoption by the Ontario Commission.

The problems to be solved by this Committee were not by any means all simple ones. The Committee met from time to time and considered various proposals and types of insurance contracts; tenders were called for from various insurance companies and finally a joint proposal made by The Confederation Life Association, The London Life Insurance Company and The Mutual Life Assurance Company of Canada, was accepted by the Committee and recommended to the Commission for adoption, and this policy, as originally recommended is the one finally adopted by the Commission after various conferences with the Municipal Committee.

I think I am right in stating that one change, and only one, was made in this policy, viz., the dropping from the policy of the proposed disability benefits, and this change, as I have stated, was made after various conferences, between your Committee, the Commission and various expert advisers and unanimously agreed to by all.

But with the policy and the benefits settled there remained other important and difficult questions to be solved before the scheme could be launched.

Perhaps the outstanding of these questions was whether each municipal commission should be considered as a separate and independent unit without any connection or interest in or with the other municipal commission, or whether all the local commissions should be grouped.

The Ontario Commission's attitude was that the responsibility for determining this and various other questions rested with the Committee representing the local commissions.

As the result and outcome of various conferences the Commission therefore passed to the Municipal Committee the responsibility for determining the plan and settling the details of the necessary contract, subject perhaps only to three main principles:

1. That the local commissions must know in advance what the scheme is going to cost them.
2. That the employee must know, as far as actuarial advice can be relied upon, what benefits he will be entitled to.
3. Stability of cost and of benefits.

The Commission had in mind the many insolvent pension schemes, as a result of which public bodies have had to face disagreeable alternatives—first, pay much more than was originally contemplated towards the support of the scheme by annual grant or otherwise or, cut down the benefits to the employees, or perhaps compel employees to pay a much higher contribution than was originally intended—these pitfalls were to be avoided—but, as I have said, subject to these few general principles the Committee was told to go ahead and settle its own scheme and contract.

Many meetings of the Committee followed with the final result that what may be called the group principle was unanimously adopted by your Committee and recommended to the Commission.

The necessary contract to bring the scheme into effect was practically completed at a joint meeting between your Committee and the Commission a few days ago.

While there have been many delays in the past I can see no valid reason for any further serious delay in settling the necessary insurance policy and the necessary contract for signature by the municipal commissions. When that is done there remains nothing but for a sufficient number of the municipal commissions to sign up and the scheme can then be brought into force.

What The Scheme Provides.

The scheme contemplates covering without medical examination practically all the present employees of each local commission that enters into the scheme, and each of the employees under the policy will be entitled to a pension for life on retirement—a death benefit and certain rights on leaving the service.

The normal age for retirement is 65, but provision is made for retirement from age 55 to age 70. Pensions for retiring at 60 are about one-half and for those retiring at 70 somewhat larger than the normal pension at 65.

I cannot attempt to outline in detail the benefits, but I have had two or three examples worked out which will give you some idea as to how these benefits do work out, for instance:—

1. Mr. "A" enters a service at age 25 at a salary of $1,200.00 a year, or $100.00 a month, he continues in the employment of the municipal commission at the same salary until age 65, when he retires on pension—This Mr. "A" at the age of 65 will be entitled to a total retiring allowance of $81.43 per month.

2. Mr. "B's" present age is 50. He has served for 30 years and has completed 18 years of service since 1910. His present salary is $3,000.00 a year or $250.00 a month. He continues in the employment of the municipal Commission and when at 65 he retires on pension he will be entitled to $96.18 a month.

Under the contract and policy as proposed each individual will receive each year a card showing exactly his rights under the policy. In case of death during the employment there is paid as a death benefit from one to one and one-half year's salary, according to length of service.

After 20 years of service an employee will take with him the right to the benefits already purchased for him by the municipality.

What it Will Cost the Municipality

In order to take up the accrued liability for past services of old employees the municipal commission may require to pay an amount not exceeding 1¼ per cent. of the present pay-roll for 30 years, and for the future services the municipal commission must pay five per cent. of each year's pay-roll.

You will observe that if the rights of the old employees to consideration were to be forgotten the total cost now, or in the future, would not exceed five per cent.—but for reasons which I think will carry the approval of public opinion these old pioneer hydro employees deserve consideration.

Cost to the Employee.

Each present employee of the commission, young or old, will be required to contribute 2½ per cent. of his monthly salary to the up-keep of the scheme, and future employees entering the service over age 25 will be required to pay in addition to this 2½ per cent. an additional percentage to cover the extra cost by reason of the increased age, and no future employees over the age of 45 can be admitted to the scheme.

General Observations

In my earlier remarks I referred to insolvent pension schemes. In the past many of these were brought into force without any actuarial advice as to ultimate cost. The vital point in the present scheme is that upon the best and most conservative type of actuarial advice the benefits outlined in the policy can be paid in perpetuity on a five per cent. payment by the local commissions and the percentages as laid down by the employee. It would be perfectly easy to go into the insurance field and secure a group policy giving the same benefits as those in the policy that we have adopted at much lower rates than five per cent., for the reason that the ordinary group policy pays current cost and leaves the future to take care of itself.

In my opinion it never would have done for the Ontario Commission to have consented or the municipal commission to have adopted a type of pension scheme at current costs. That is not the solid way or the way in which Hydro undertakings are being taken care of.

In short, the Commission insisted and the Municipal Committee approved that any pension scheme adopted must be made actuarily solvent by adequate reserves.

I cannot attempt to deal with the provisions of the contract as between the various municipal commissions—I can only say that it has been worked out with great care and makes due provision for ultimate equality amongst all the municipalities that enter into the scheme.

Mr. Chairman and Gentlemen, various forms of group benefit insurance are sweeping over this continent —In my judgment public opinion will not justify big industry or business "scrapping" old time employees and leaving them to the support of relatives or public charity, and much less will public opinion justify public utility commissions scrapping their worn out employees without making some provision for them.

As a matter of fact public commissions realizing the trend of public opinion do not usually scrap their old time employees but try to take care of them by keeping them on jobs where they are no longer efficient. It looks like better business to do it under a sound Pension Scheme.

Discussion

Mr. R. T. Jeffery of Ontario: As a matter of information, Mr. Lucas, while the existing employees do not have to pass any medical inspection, I understand all the new ones will.

Mr. Lucas: No. While there are some reservations made the general scheme does not contemplate medical examination either for old or new employees.

Mr. H. F. Shearer, Welland: Mr. Lucas, is provision made for an employee transferring from one municipality to another.

Mr. Lucas: Yes. You can go from one municipality to another and carry your benefits, except your past service benefit, and as that is paid for by the individual municipality you cannot take it with you, although there is a provision that if you have served 20 years you may do so.

Mr. E. V. Buchanan, London: I would like to ask Mr. Lucas if that applies to an employee who has transferred from one municipality to another in past years.

Mr. Lucas: I am afraid it does not apply to transfers made in past years.

Mr. Buchanan: In my municipality at the present time there are several civic departments under one commission called the Public Utilities Commission, such as Street Railways, Gas, Water, Public Parks and Playgrounds. Some of these departments are not working under a general Act such as the Public Utilities Act, but under special Acts such as the London Waterworks Act, in which there is no provision for paying of pensions. The Public Parks Department was created by a special Act. There are no employees there now. Many of them have become joint employees, and these employees would only then receive benefits to the extent of one-quarter or one-half of their salary.

Mr. Lucas: If there is a general Public Utility Commission under the general law I think the legislation is wide enough for all to come in.

Mr. Buchanan: The London Public Utilities Commission was first of all created as the Water Commission of the City of London by special Act of the Provincial Legislature. To that was added, at a later time, the Hydro-Electric Department by special Act, placing the Hydro-Electric Department under the Water Commission and subject to certain enumerated clauses in the London Waterworks Act. A few years later, the Department of Public Parks and Playgrounds was added by a special Act. Now, you see, if there is any legal obstacle there, I am quite sure the London Public Utilities Commission would throw over the whole scheme, because they could not discriminate amongst their employees.

Mr. Lucas: I have some general recollection of the special London legislation. At the moment I am not prepared to say whether our authorizing legislation is wide enough to cover the London situation, but your Commission is within the spirit of the legislation.

Mr. Buchanan: Then it would be necessary, I presume, for London to apply for a Private Bill for legislation to cover that point.

Mr. Lucas: I should not say a Private Bill. I would suggest, if there is a necessity, some amendment to our authorizing Act.

Mr. Buchanan: Under present legislation.

Mr. Lucas: Yes, Mr. Buchanan. If there is any technical difficulty

in the way, my suggestion would be not a Private Bill but a very minor amendment to the Act making "Municipal Authority" wide enough to cover your Public Utilities Commission.

The Protective Relay Installation at the Toronto-Leaside Transformer Station

By E. M. Wood, Electrical Engineering Dept., H.E.P.C. of Ont.

(Presented at the Annual General and General Professional Meeting of the Engineering Institute of Canada at Hamilton, Ont., February, 15th, 1929.)

THE protective relay installation at the Toronto-Leaside transformer station of the Hydro-Electric Power Commission of Ontario is only a part of the protective relay equipment on a whole transmission system. This system is designed to perform certain functions, and in this case the application of protective relays has the purpose of enabling it to carry out these functions continuously in case of failure of any apparatus or circuit as will occur at times even in well insulated systems. It is advisable, therefore, first to present an outline of the transmission problem for this particular system and the system diagram which was decided upon to accomplish this, after which the application of relaying to the system and to the Toronto-Leaside transformer station in particular will be discussed in some detail.

On October first, 1928, the Hydro-Electric Power Commission commenced taking power from the Gatineau Power Company under a contract which calls for the delivery of 25-cycle power to the Commission in increasing amounts from time to time up to a maximum of 260,000 h.p. in 1931.

This power is at present generated in three plants of the Gatineau Power Company on the Gatineau river in the province of Quebec and is to be used by the Commission to take care of the growth in load in their 25-cycle Niagara system which extends from Toronto to Windsor. Up to the present, this system has been supplied by the generating plants of the Commission on the Niagara river, which are now fully loaded.

The Gatineau generating stations at Farmers rapids, Chelsea, and Paugan falls are connected together by a system of 110-kv. lines, and at Paugan the voltage is transformed to 220-kv. Power is transmitted from that station over a system of 220-kv. transmission lines to the northeastern outskirts of Toronto, where the voltage is transformed by banks of three-winding transformers and the power fed into the existing Niagara system over 110-kv. lines and to the 13 kv. distribution system of the Toronto Hydro-Electric system.

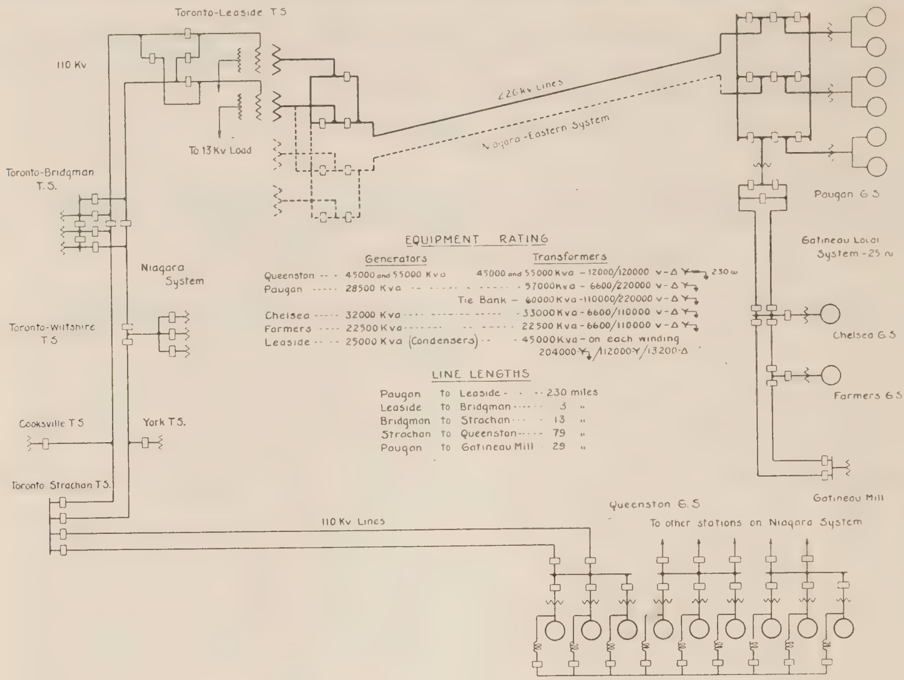


Fig. 1.—Diagram of Interconnected Niagara, Niagara-Eastern and Gatineau Systems.

The high voltage, (110 kv. and 220 kv.), lines built or proposed for the interconnection between the Niagara generating stations, Toronto, and the Gatineau generating stations, with the essential switching, are shown in diagram in fig. 1. Particulars as to equipment and lines are tabulated thereon. This interconnected system naturally divides into three main subsystems as follows:—

(*a*) The Toronto subsystem of the commission's Niagara system, including the Queenston generators which are on Toronto load, the lines from Queenston to Toronto, and the 110-kv. step-down transformer stations at Toronto. This is connected to the remainder of the Niagara system through the 12-kv Queenston paralleling bus.

(*b*) The Gatineau Company's 110-kv. 25-cycle system from Paugan to the Gatineau mill, including the generating stations at Farmers rapids and Chelsea.

(*c*) A subsystem between (*a*) and (*b*) consisting of the Paugan generating station, the 220-kv. transmission system, and the transformer station at Toronto.

The three subsystems may operate separately or connected together. Subsystems (*a*) and (*c*) are connected together through the Leaside transformers and 110-kv. tie lines to the Toronto-Bridgman station of the Commission. Subsystems (*b*) and (*c*) may be connected together through

one or more 60,000-kv-a. 220/110 kv. tie banks at Paugan.

The Toronto terminal of the Paugan-Toronto 220-kv. transmission is known as the Toronto-Leaside transformer station. It is located in the municipality of Leaside, close to the city, and in a particularly favourable position for connections to the existing 110-kv. system and for supplying the load of a large part of the eastern half of the city at 13 kv.

The wiring diagram of the station for handling 260,000 h.p. from the Gatineau is shown in figure No. 2. This diagram has some unusual features which are worthy of note.

(1) The station consists of a number of distinct elements, each connected to and separable from the other elements by automatic oil circuit breakers.

These elements fall into two classes:—

(*a*) Elements which lie entirely in this station, and which will be hereafter called "zones." These are:—

Four transformer zones, each consisting of one 45,000-kv-a. transformer bank with its power wiring as far as and including the oil circuit breakers in the various connections.

The voltage rating of each transformer bank is:—

H.V.—194–204–214 kv. star-connected with dead grounded neutral.

M.V.—112 kv. equipped for tap changing under load with a range of $\pm$ 7½ per cent in steps of 2½ per cent. each. The bank is star-connected with neutral not grounded at present.

L.V.—13.2 kv. delta-connected. This winding is grounded through a zig-zag grounding reactor.

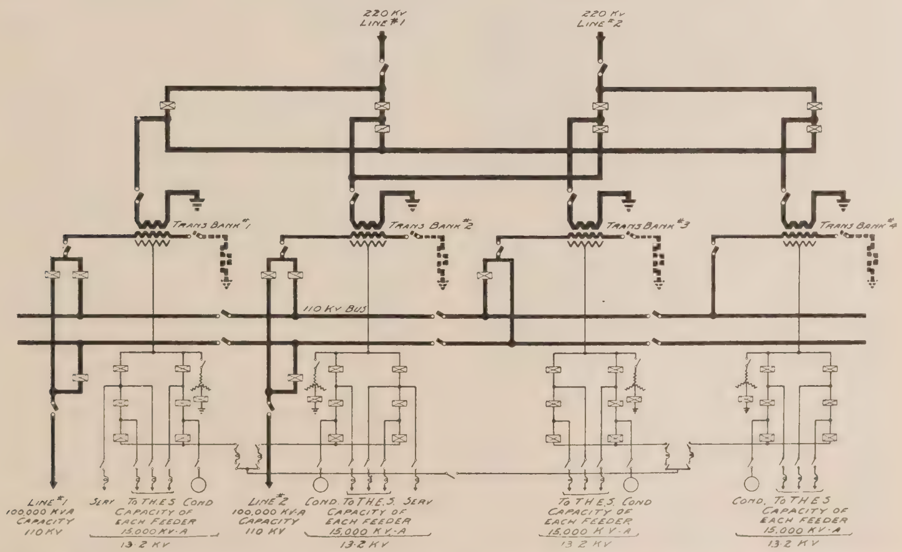


Fig. 2.—Toronto-Leaside Transformer Station, Diagram of Main Connections.

Four condensers with supply cables and accessories, including the oil circuit breakers. These condensers are intended to control the voltage automatically on the 13.2-kv. system. One 13.2-kv. paralleling bus, with its necessary reactors and oil circuit breakers. This is intended to tie together the 13-kv. banks and feeders.

If load developments require there may be two 110-kv. busses.

(*b*) Lines or feeders interconnect this station with other stations, and, of course, only one end of each is at Leaside station. They are as follows:—

Two incoming 220-kv. lines from Paugan.

110-kv. lines to other Toronto stations as required by load developments. At present there are two to Bridgman transformer station.

13.2-kv. feeders of 15,000 kv-a. capacity each as required by load developments. At present there are four feeders to the Carlaw transformer station of the Toronto Hydro-Electric System.

(2) Each element has at least two connections through oil circuit breakers. On high voltage lines the limit at present is two, on account of the characteristics of the current transformers and relays. On zones this limitation does not apply.

(3) The elements are arranged in what amounts to a series of rings. This is well shown in Fig. 3. The 220-kv. parts of elements are arranged in a ring with diameter, the banks and lines alternating so far as possible.

The 110-kv. elements are arranged in ring with lines and banks alternating. This, however, would develop into a sort of double bus scheme, as shown in Fig. 3.

The 13-kv. elements group together into units which will each correspond to one transformer bank. Each unit will consist of the 13-kv. bank wiring, two or three feeders, one condenser and a connection to the paralleling bus, through a reactor, if this is required to keep down short circuit currents. These six elements are in a ring which may be supplied from the corresponding bank, or from other banks through the bus, or from both.

The arrangement can be seen from Figs. 2 and 3. Construction of any element may be delayed until it is needed.

There are at present two units with two feeders each. The third feeder will be added or additional units constructed as the 13-kv. load develops.

This arragement gives, we believe, a maximum of flexibility and security with a minimum number of breakers.

(4) On account of the small number of breakers, normal operation will be with all breakers closed.

On the other hand, the arrangement permits any *one* breaker to be taken out of service without notice for inspection or maintenance, to try its operation or keep it in good operating condition. This will facilitate proper maintenance and will overcome the tendency to fail to operate, which occurs when a breaker is left standing for months without operation.

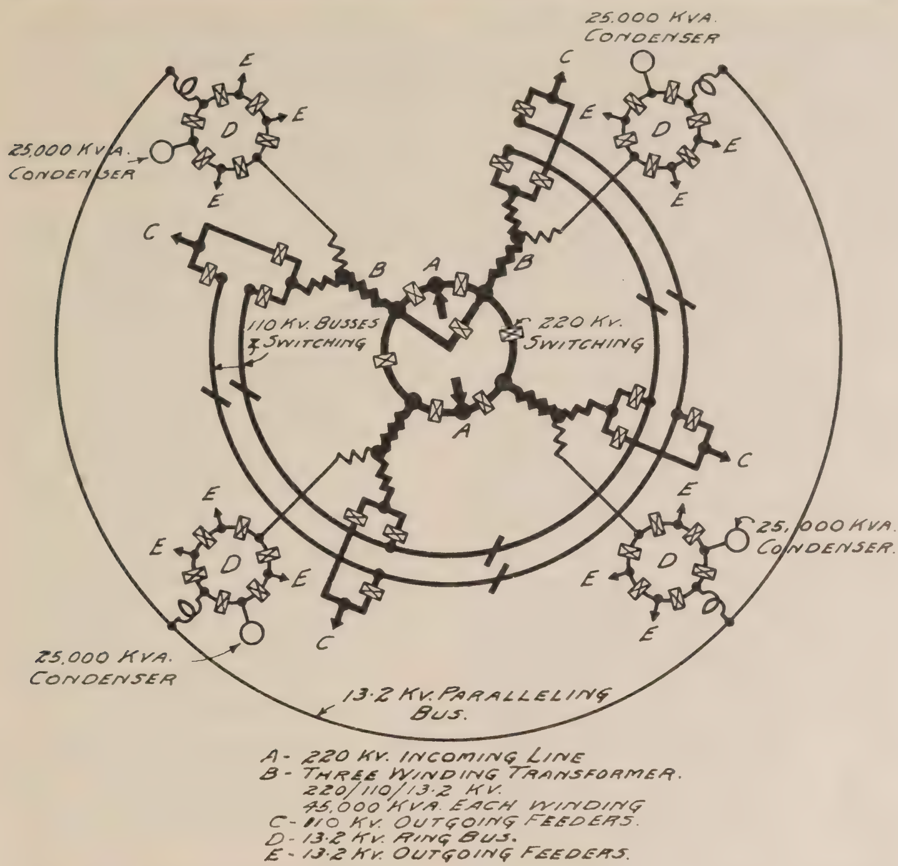


Fig. 3.—Toronto-Leaside Transformer Station, Schematic Circle Diagram 220/110-13.2 Kv. Main Switching

(5) Each piece of equipment or line has a set of gang-operated disconnecting switches by which it may be cleared from the ring if it is to remain out of service, thus allowing the breakers to be closed, completing the ring.

It is expected that at least lines can be picked up by closing the disconnecting switches without using the breakers.

(6) The arrangement in separable elements permits any element to be disconnected from the system if a fault develops, without disturbing the rest of the system. It also lends itself to the application of relaying which will accomplish this.

(7) Each breaker belongs to two elements.

These same principles have been applied at the Paugan generating station and are being extended to important switching stations on the Niagara system wherever it is advantageous to do so.

Protective Relaying at Leaside General Requirements

In the design of the protective relaying on this system, including that at the Toronto-Leaside transformer station, the following requirements were kept in mind:—

The protection at the various stations must be so co-ordinated that all parts will function in their proper relation to the whole system.

It must be suitable to the operating requirements of the system and to the diagram of connections, and, conversely, the present possibilities of effective relaying should be one consideration in deciding upon the diagram.

The purpose of the protective relaying is to promote continuity of service throughout the system by detaching therefrom any equipment or circuit which is creating a disturbance to the delivery of power due to its faulty condition. In a system of this sort, with various generating stations and numerous switching stations, failure of a faulty section to be cleared automatically by relaying presents a very awkward situation to the operators. They have plenty of evidence in voltage disturbance and behaviour of apparatus that there is trouble on the system but very little evidence to aid in locating it. The relaying should therefore be effective under all desired operating conditions. The operator should be free to use any arrangement of available lines he requires at short notice. He should also be free to connect to generator capacity to suit his load conditions, whether light or heavy. Under all these conditions his relay system should be dependable.

The faulty element must be separated from the system quickly for the following reasons:—

(*a*) To prevent serious damage to faulty or sound equipment or cables.

(*b*) To prevent permanent damage to circuits or spread of arc on a line to other phases or to sound circuits. If the faulty overhead *line* can be cleared instantly it can in the great majority of cases be switched back into service at once. If there is any considerable delay it is likely to require repairs before it can be used.

(*c*) To prevent "shake up" of the system with resultant loss of synchronous or other load or loss of synchronous stability between generating stations.

The system should be simple in principle so that it can be readily understood, and be easy to adjust and maintain.

In the station, the characteristics of relays, current transformers, cables, control circuits and oil circuit breakers must all be taken into account and co-ordinated into a system which may be depended upon to give the desired results.

The relay system should clear any faulty element without detaching any sound element. It must, under no circumstances, operate to give an interruption to service when there is no serious fault existing on the system.

The protective relaying installed at Leaside to meet these requirements falls under three general classes as follows:—

Complete Instantaneous Protection.

Complete instantaneous protection to clear any phase-to-phase or phase-to-ground faults in the station or on the lines or feeders instantaneously or at longest in 15 cycles relay time. On the station "zones" the protection is of the differential type. In the case of long lines and feeders, the protection is of the directional disance type. Short lines are equipped with pilot wire protection. These will be described in more detail later. Each operates to isolate its own unit if defective. It is designed to function properly with a minimum of one generator connected to the system at Queenston or two at Gatineau. Each zone protection, and to a large extent each line protection, has the additional desirable feature that it pays no attention to any faults outside its own well defined area. When relays are working properly and the breakers open when tripped, the faulty section will be isolated with practically no disturbance to the rest of the system. This will occur in every case where the relays and breakers are properly maintained.

Separating Standby Relays

However, all equipment is fallible and it is necessary to take care of such a contingency. For this purpose *standby* distance or residual ground relays are used, operating on the current through the banks which tie subsystems together. These relays are timed to allow the instantaneous zone or line relays to clear if they will. They operate to separate the subsystems, preferably in such a way that the generating capacity of each subsystem is approximately equal to the load, so that the sound subsystems may carry on.

Final Standby Relays

Time selective with these again are distance relays on the generator units which "kill" the defective subsystem after it has been separated from the sound ones.

Types of Relays Used

In this particular system and in many trunk line transmission systems of similar nature, there are two requirements in the relays which are difficult to meet.

(1) The amount of connected generator capacity and the number of lines and banks in parallel must vary from time to time so that at times the fault current in a circuit may be less than the current it is carrying at other times under normal load conditions. This prevents the use for phase-to-phase faults of the directional inverse time excess current relay, although this type may be successfully used with residual currents for single wire ground faults.

Selectivity must be obtained by other means; in this case by confining the range of a relay to a zone by the differential connection; or to a length of line by the distance principle; or by selective timing. In either case the relays, being non-operative on load current alone, may be set for currents lower than ordinary load value to take care of low load condition.

(2) On high voltage systems the most practicable place to mount current transformers for relaying is on the terminal bushings of the oil circuit breakers or transformers.

These current transformers have long cores, and require high magnetizing components of current for even low voltage induced in the secondaries. With parallel infeeds to zone or line all current transformer cores in parallel must be magnetized to give sufficient secondary voltage to trip the relays smartly, and this causes the actual ratio of the group to be very much higher than the nominal value.

In order to use such an arrangement of current transformers it is necessary to keep down the impedance of secondary windings, leads and relay windings to the very lowest possible values.

To meet these requirements we have used relays of the following types:—

(1) A plunger type current relay of a counter balanced arm type instantaneous as to time, with a wide range of settings, and with very low impedance windings. These are used for zone differentials, ground residual currents and similar purposes where such a relay is required.

(2) An instantaneous adjustable distance-range relay. This has been described, with its characteristics and some uses, in a paper given before this Institute by Mr. Paul Ackerman, A.M.E.I.C., and published in The Engineering Journal for December, 1922.

Briefly, this relay takes cognizance of two phenomena which accompany a system fault, namely, increase in current and drop in voltage.

When applied to a circuit a solenoid at one end of a lever exerts a pull proportional to the line current, and is opposed by a solenoid on the other end which exerts a pull proportional to the line voltage. The current coil tends to close the relay contacts. If the ratio $\frac{\text{Volts}}{\text{Amps}}$ at the relay is greater than a certain value at which the relay is set the contacts remain open; if not the current overpowers the voltage and the contacts close. This ratio $\frac{E}{I}$ represents an impedance,—the impedance of the line to a point which is the distance range of the relay. If the fault is nearer to the station than this point, the relay contacts close. If the fault is beyond the point, the relay contacts remain open.

It will be seen that such a relay meets our requirement that it may be set at less than full load current and will only trip when the line is faulty within a predetermined distance. If potential and current are available, it may be used wherever it is customary to use an excess current relay, with the advantage that it may be made to be effective independently of the amount of generator capacity connected or the arrangement of lines or circuits.

The relay is made selective, either by its setting range so as not to extend beyond the line on which it is used, or by timing.

The range of the relay for a given setting, of course, depends on the characteristics of the line, which must be known when the setting is made.

In order to prevent tripping due to the distance contacts closing when the relay is dead, each distance relay is always placed in series with the contacts of a current relay of the type described above, so that the distance relay can not trip any breakers unless the line is actually carrying current.

The distance relay, when set below ordinary load current of the line, as it often is, depends on the potential circuit to hold its contacts open in ordinary operation. Potential transformers sometimes fail or fuses blow, or the potential circuit may be accidentally opened, which would cause tripping without any fault on the line. Wherever the circuit is so important that we cannot afford to have accidental tripping and where the current setting is below normal load, a *duplicate* set of distance relays is installed, using the same currents as the main set but taking potential from a different set of potential transformers. The contacts of the main and duplicate relays of each phase are in series, so accidental loss of one set of potentials will not cause tripping.

(3) A plunger type excess-potential relay very similar to the current relay described above. This is chiefly used as a ground indicator.

(4) An adjustable definite-time auxiliary relay of accurate characteristics.

(5) A single-phase power directional relay which is very sensitive and quick acting.

(6) A multi-point control relay to handle the tripping current of breakers which is too great to be handled by the primary relays. The coil on this is operated from the control battery and takes very low current. The contacts may be grouped in any desired manner.

Each of these relays carries a mechanical semaphore as an operation indicator. The definite-time relay also indicates by a marker, in connection with the setting dial, how far the relay has travelled,—that is, the time-duration of the fault.

These indications on all the relays of the installation give information of great value in analyzing fault conditions, in tracing trouble in the relay system itself, and give a very valuable perpetual check on the condition of the relay system.

Each piece of equipment in the installation has a definite function to perform, and may be easily checked as to its ability and correct adjustment to perform this function. The relay panels are laid out with this in view.

Continued in April Number

Ontario Municipal Electric Association

Report of Annual Meeting, January 23, 1929.

The meeting was called to order at 2.30 p.m., President C. A. Maguire in the chair.

The minutes of the last Annual Meeting were taken as read, on motion of Commissioner Fred Harp, Brantford, and seconded by Commissioner Geo. Wright, Toronto.

The Secretary then presented his report as follows, which was adopted on motion of Commissioner Carl Kranz, Kitchener, seconded by T. W. McFarland, London.

Executive's Report

To the Officers and Members of

the Ontario Municipal Electric Association.

Gentlemen,—

Our last Annual Meeting was held in the King Edward Hotel, Toronto, on the 18th and 19th of January, 1928, and the attendance and interest at our Association meetings was better than for some time past. The general attendance at the Convention of the two Associations exceeded in point of numbers and in interest that of any previous meeting.

The Summer Convention was held at the Clifton House, Niagara Falls, and was also very largely attended, and we believe gave an opportunity not only for a very pleasant outing and much enjoyment for the delegates, but also an opportunity for the acquiring of information along the line of Public Ownership development, both as applied to the power houses at Niagara Falls and Queenston, and also in respect to the new Welland Canal.

Through the kindness of Mayor H. P. Stephens, of Niagara Falls, a trip was arranged to look over the development of the new Welland Canal and this was taken advantage of by a great many of the delegates present, I believe to the advantage of all who had an opportunity of inspecting this great work.

The speeches at both the Annual Convention as well as the Summer Convention were of a high order and the amusements offered were exceptionally attractive, entertaining and amusing.

During the past year there have been many things that have engaged the attention of your Executive, some of which I may be permitted to mention as briefly as possible.

It is a matter of more than ordinary interest to us to know that the Hydro system is advancing faster than ever before. The original seven municipalities having now grown to some five hundred and fifty and the original less than a thousand horse power has grown to more than a million and during the last few years the power lines in rural districts have been growing at the rate of three miles for every working day.

The Commission and the Government are to be congratulated on the foresight and ability they have shown in making arrangements for further supplies of power; contracts having been entered into with power interests in the Province of Quebec for additional supplies of power amounting to more than a quarter of a million horse power to be delivered as needed for the purposes of the municipalities and industries of this Province, and at very advantageous rates.

We understand that negotiations have also been carried to a successful conclusion with the Government of the United States for a further diversion of some ten thousand c.s.f. of water at Niagara Falls to be used under certain conditions which will have the effect of taking care of the power needs of this Province for some considerable time to come.

The first block of power from Quebec was turned on at Leaside, adjoining the city of Toronto, on October 1st, and the work in connection with this transmission line and the construction of the power station reflects great credit on the Engineering staff of the Ontario Hydro Commission.

You, no doubt, are all familiar with what has taken place the past Fall in the Bruce Peninsula where a private company from the United States purchased the rights of a local company which was serving the municipalities of Walkerton, Southampton and Port Elgin.

At the request of municipal officials representatives of our organization, together with engineers from the commission visited the district in the late summer and finally a by-law was submitted in the town of Southampton which was carried by the ratepayers on the basis of about two to one and it is expected that in the near future by-laws will be submitted in some of the other municipalities affected.

However, the private company seems to be looking for trouble and tell us they are going to fight and at the New Year they submitted by-laws or resolutions in a number of rural municipalities and are continuing construction despite the fact that they know both the Government and Commission as well as a majority of the people in the district are opposed to their system and in favor of public ownership.

The Beauharnois Light, Heat and Power Company are asking the Dominion Government for a permit to divert forty thousand c.s.f. of water from the River St. Lawrence which is being vigorously opposed by the Dominion Marine Association, the shipping interests generally and many of the power interests; among the many objections to the permit some stating that it will be a danger to navigation.

It is understood that the plans have been considerably modified from the beginning; that it was their intention to divert more than this amount originally and in fact it is generally admitted that if they get this amount it will only be a short time until they are back for more.

Chicago Drainage Canal

For several years past the Members of our Association as well as the power users generally, have viewed with alarm the attitude of the City of Chicago in respect to diverting water from the Great Lakes which has had the effect of materially lowering the water levels and was a great injury not only to the development of power but perhaps even more so to the shipping interests both in Canada and the United States.

For several years past the States bordering along the Great Lakes, together with the Province of Ontario and particularly the City of Toronto. have through the Great Lakes and Harbours Association, of which our President has been Vice-President for some years, carried on a very determined, courageous battle for the rights of the people before the United States Government; and finally through the courts in hope of obtaining a measure of justice.

The action of the United States Supreme Court in deciding that the action of the City of Chicago was illegal, that the diversion was never authorized and that a perpetual injunction is to be granted against any further extraction of water from Lake Michigan, came as a very gratifying New Year's gift, to the men who have carried on this battle against what seemed overwhelming

odds and I believe our Association as well as the people of this Province owe a debt of gratitude to Mr. Bruce, the President of the Great Lake Association and his associates and co-workers for what has been done.

Beck Memorial

Some few months ago your Executive was approached by representatives of the City of London with the request that we recommend to the Ontario Commission the granting of $25,000 to a fund for the purpose of purchasing the home of the late Sir Adam Beck; the City of London to make a similar grant of $25,000; and the balance of $15,300 to be raised by public subscription among the citizens of London, and that the City of London would agree to maintain the residence and premises in perpetuity under their Parks Board.

Your Executive decided to refer the matter to the local Commissions and to the Association at the Annual Meeting. Letters have been sent out to all the cities and towns in Ontario as well as a number of villages and only a small proportion have as yet replied and while the majority seem to favor the proposal, there are others which are opposed and which I expect will be represented here today, so that this matter may have a full and frank discussion.

Your Pension and Insurance Committee have been working continuously since our last meeting and with the help of the Commission have, we believe, succeeded in securing more favorable terms than we were offered some time ago and we believe the agreements are now in such shape that every possible safeguard has been provided for and we expect that a report will be presented at this Convention.

During the summer, memorial services were held in the Cemetery at Hamilton on the anniversary of the death of our late chief and it is worthy of note that in these times when people are forgotten very quickly that the attendance at Sir Adam's memorial is increasing every year showing that the people have not forgotten his great achievements and that he still holds a warm place in their hearts and affections.

We regret to note that we have lost two more of the old guard, James Shepherd, ex-Mayor of Windsor and a Hydro Commissioner from the beginning of their system and one of our Directors, was taken away this summer; and John R. Robinson, for many years the Editor of the Telegram and a staunch exponent of public ownership and a fearless advocate of Hydro at all times, has also gone and left his work in other hands but we may say of them that they were loyal and true and faithful friends of Hydro.

This is a brief summary of some of the principal activities of your Executive; and happenings which are of importance to our organization and we believe that while we have been extraordinarily successful up to the present we should not be willing to let things rest at that, but should let the past be an inspiration to us to go on and in our different ways do our utmost to carry out the vision of the late Sir Adam Beck that all the dark places of Ontario be made bright and that Hydro light and

service be eventually carried into every home in this Province.

Treasurer's Report

The Treasurer's report was presented, giving an itemized statement of receipts and expenditures and showing a balance of $188.66 in the bank, which was adopted on motion of Mr. Jennings, of East York, and seconded by Mr. Harry Kirwin, of Scarboro.

President C. A. Maguire then addressed the meeting, reports of which appeared in the daily papers.

The proposal to endorse a grant from the Hydro Electric Power Commission to the City of London for the purpose of taking over the home of the late Sir Adam Beck as a memorial was taken up and the Secretary read a number of letters from the different Municipal Commissions in respect to same but said that up to the present time there had not been sufficient response to give any definite opinion as to the views held.

The resolutions respecting memorials were as follows:

London Resolution

Moved by C. W. Anderson, Niagara Falls; seconded by Harry Kirwin, Scarboro.

That we recommend to the Ontario Commission the securing of legislation to grant the request of the City of London under the terms and conditions as set forth in the letter forwarded to the Municipal Commissions by our Executive.—Carried.

Baden Hill Resolution

Moved by Mayor J. A. Andrew, Stratford; seconded by Commissioner Carl Kranz, Kitchener.

That it is the opinion of this Association that a public memorial to Sir Adam Beck should be erected on the Baden Hill near the place of his birth and in the midst of the thickly populated section of Ontario which has benefited so largely from his activities.

This location is approximately midway between Sarnia and Niagara Falls on the Provincial Highways Nos. 7 and 8 between the cities of Kitchener and Stratford, and the hill on which it is proposed to erect a memorial is one of the highest points in Ontario and has ample ground for conversion into a splendid public park.—Carried.

Research Resolution

Moved by Commissioner T. W. McFarland, London; seconded by Commissioner Fred Harp, Brantford.

That the Hydro Electric Power Commission be requested to submit a report at the next meeting of this Association showing the extent to which it is possible to extend the work of testing and research in the Commission Laboratories.

The resolution was carried unanimously.

Resolution Re Publicity

Moved by Commissioner George Wright, Toronto; seconded by Commissioner F. Newman, Picton.

Resolved that in the opinion of this Association there should be available to the Hydro Electric Power Commission of Ontario, funds for publicity purposes and to combat anti-Hydro propaganda and for such other purposes as may from time to time appear to be in the general

interests of all the Hydro Municipalities and that to raise the necessary funds for such purposes a small charge should be made, limited to say not more than 5c per horse power and that the Hydro Electric Power Commission of Ontario be requested to secure the necessary legislation to give effect to the above.

The resolution was carried unanimously.

BEAUHARNOIS RESOLUTION

Moved by Mr. Fred Newman, Picton; seconded by Mr. Geo. Wright, Toronto.

That the Dominion Government be requested to delay action re the Beauharnois Canal until final decision has been rendered as to the power rights and ownership of the waters of the St. Lawrence River.

The report of the Nominating Committee was read by the Secretary as follows:

President, C. A. Maguire, Toronto; Vice-Presidents, W. Ellis, Hamilton; August Lang, Kitchener; Fred Newman, Picton; T. W. MacFarland, London; Secretary-Treasurer T. J. Hannigan, Guelph; Directors Fred Harp, Brantford; J. F. Craig, Barrie; H. P. Stephens, Niagara Falls; F. Biette, Chatham; Geo. B. Challies, Morrisburg; J. B. Miller, Orillia. Col. Green, St. Thomas; W. Reynolds Brockville; and the President of the Engineering Association.

Moved by C. Kranz, Kitchener; seconded by Jas. C. Scott, Niagara Falls:

That the report of the Nominating Committee be received and adopted and the Secretary be instructed to cast one ballot.—Carried.

Secretary cast one ballot and the Officers were declared duly elected.

Meeting adjourned at 5.30 p.m.

Association of Municipal Electrical Utilities

MINUTES OF EXECUTIVE COMMITTEE MEETING

A meeting of the Executive Committee was held at the King Edward Hotel, Toronto, on January 23, 1929, at 10 o'clock p.m. Officers for 1929 present were as follows:

Messrs. A. W. J. Stewart, President; J. G. Archibald, R. L. Dobbin, O. H. Scott, J. R. McLinden, D. J. McAuley, R. H. Starr, A. L. Farquharson, J. E. B. Phelps, T. J. Hannigan, J. W. Peart and S. R. A. Clement.

Immediately after the meeting had opened, Mr. Jas. Reid, Manager of Bigwin Inn, was invited to attend. Mr. Reid outlined to the Committee the facilities offered by his hotel for holding a Convention, and discussed briefly various features in the matter of what would be done in the event of the Association holding its Convention there. He advised that the hotel would be in a position to handle our Convention on June 19, 20 and 21. After Mr. Reid had retired, the Committee discussed the matter of place of meeting for the Summer Conven- at some length. It was moved by Mr. R. H. Starr and seconded by Mr. J. R. McLinden, THAT the Summer Convention be held at the Bigwin Inn on June 19, 20 and 21, 1929,* subject to satisfactory arrangements being made.—*Carried.*

The Committee then proceeded to arrange for the various sub-Committees for the coming year, which were decided to be as follows:

Papers Committee—O. H. Scott, Belleville, Chairman; E. V. Buchanan, London; P. B. Yates, St. Catharines; C. S. Barthe, Canadian General Electric Co., Toronto; Jos. Showalter, Canadian Westinghouse Co., Toronto, G. F. Drewry and G. J. Mickler, H.E.P.C. of Ontario, Toronto.

Convention Committee—R. L. Dobbin, Peterboro, Chairman; R. H. Star, Orrilia; J. W. Peart, St. Thomas; H. F. Shearer, Welland; M. B. Hastings, Powerlite Devices Ltd., Toronto; H. C. Barber, Standard Underground Cable Co., Toronto; F. Mahoney, Canadian General Electric Co., Toronto; and J. W. Purcell, H.E.P.C. of Ontario, Toronto,

Regulations and Standards Committee—J. R. McLinden, Owen Sound, Chairman; V. B. Coleman, Port Hope; J. J. Heeg, Guelph; E. I. Sifton, Hamilton; W. P. Dobson, H.E.P.C. of Ontario, Toronto; A. G. Hall, Electrical Inspection Dept., Toronto.

Committee on Accident Prevention and Health Promotion—A. L. Farquharson, Brockville, Chairman; C. T. Barnes, Oshawa; H. G. Hall, Ingersoll; W. E. Reesor, Lindsay; C. E. Brown, Meaford; C. E. Schwenger, Toronto; C. W. Alfred, London; F. C. Adsett, Trenton; T. C. James, G. F. Drewry, Wills Maclachlan, H.E.P.C. of Ontario, Toronto.

Merchandising Committee—J. E. B. Phelps, Sarnia, Chairman; F. S. Rhodes, Windsor; A. O. Hunt, London; W. H. Childs, Hamilton; C. W. Burns, Walkerville ; I. N. Pritchard, Chatham, A. B. Scott, Galt; R. S. King, Midland; J. J. Heeg, Guelph; O. H. Scott, Belleville; H. F. Shearer, Welland; and G. J. Mickler, H.E.P.C. of Ontario, Toronto.

Rates Committee—J. W. Peart, St. Thomas, Chairman; P. B. Yates St. Catharines; E. I. Sifton, Hamilton; E. M. Ashworth, Toronto; A. B. Manson, Stratford; E. V. Buchanan, London; A. B. Scott, Galt; O. M. Perry, Windsor; D. B. McColl, Walkerville; and all the members of the 1929 Executive Committee.

Auditors—W. G. Pierdon, H.E.P.C. of Ontario, Toronto; and H. P. L. Hillman, Toronto.

It was moved by Mr. J. G. Archibald and seconded by Mr. O. H. Scott, THAT the Committees as drafted be declared elected.—*Carried.*

The Chairmen of the various Committees were instructed to proceed at once regarding Convention arrangements, so as to be ready to report at the next meeting of the Executive Committee, which will be held some time during April.

It was moved by Mr. J. G. Archibald and seconded by Mr. J. W. Peart, THAT the Secretary and Treasurer be paid an honorarium of an amount the same as last year.—*Carried.*

The meeting then adjourned at 11.30 p.m.

* Since the Canadian Electrical Association Convention is to be held on the dates given above it was deemed advisable to arrange if possible other dates for the O.M.E.A. and A.M.E.U. summer convention. Therefore it was later arranged to hold the Convention at the Bigwin Inn on July 3, 4, and 5, 1929.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

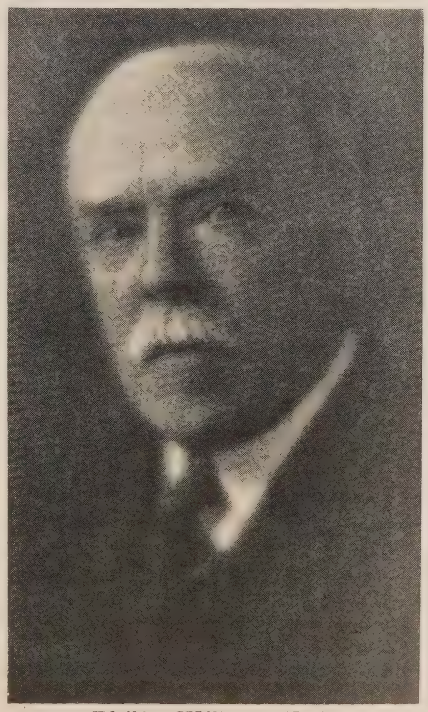
Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Philip William Ellis

IN the passing of Philip William Ellis, at St. Michael's Hospital, Toronto, on the afternoon of Sunday, April 21st, 1929, the City of Toronto lost one of her most prominent public servants and the Province of Ontario one of its foremost advocates of public ownership. Mr. Ellis had been confined to his bed for some nine or ten weeks, and on the morning of Wednesday, April 17th, underwent an operation, after which, although he made favourable progress for a short while, complications set in which resulted in his death. During his illness, Mr. Ellis kept in close touch with his public duties and had his wish fulfilled that he should die in harness.



Philip William Ellis

Mr. Ellis was born in Toronto of English parents, on September 11th, 1856; his father, Wm. Henry Ellis, former City Engineer of Liverpool, having come to Canada, in 1852, as Engineer on the construction of the old Grand Trunk Railway. He was educated at the Misses Reeve's School, the Model School and Jarvis Collegiate. He then entered the jewelry firm of C. W. Morrison, as an apprentice, and on completion of his term there in 1877, started business for

CONTENTS

Vol. XVI **No. 4**

April, 1929

	Page
Cameron Street Substation, Port Arthur - - - -	**111**
Orillia Commission Celebrates -	**117**
Rural Hydro Service, What it Costs and What it Does - -	**119**
The Protective Relay Installation at the Toronto-Leaside Transformer Station - - - -	**126**
A.M.E.U. Report - - -	**139**
Universal Safety - - -	**141**
Hydro News Items - - -	**142**

himself. From this humble beginning the firm of P. W. Ellis & Co., became one of the largest concerns in the jewelry business in the Dominion.

A brief review of the more prominent positions which Mr. Ellis filled in the field of public electrical and other service will show how extensive were his public activities.

Mr. Ellis was one of the members of the Ontario Power Commission, which was formed in 1903 by special Act of the Ontario Legislature. In 1905 the Whitney Administration appointed a Commission of Enquiry to report regarding hydraulic and electric power in the Province of Ontario. Mr. Ellis served on this latter Commission for nearly a year, resigning on account of ill health. Both of these Commissions preceded the formation of the present Hydro-Electric Power Commission of Ontario. In 1911 he became Chairman of the Toronto Hydro-Electric System, serving in that capacity until his death.

Mr. Ellis was a prominent advocate of municipally-owned electric utilities, and was an early and staunch supporter of the late Sir Adam Beck in his great work on behalf of the co-operating Hydro Municipalities of Ontario. In 1906 he was appointed a member of the Queen Victoria Niagara Falls Park Commission, and since 1915 had been its Chairman.

With the formation of the Toronto Transportation Commission, taking over the operation of the Toronto Street Railway System, Mr. Ellis also became Chairman of that body.

Industrial questions were always of interest to Mr. Ellis. He was not a theorist but a practical man in all his relations with labour. When the present Ontario Workmen's Compensation Act was being drafted, he was the Chairman of the Workmen's Compensation Committee of the Canadian Manufacturers Association. Mr. Ellis has also been an active member of the Committee responsible for the Pension and Insurance scheme for the municipal Hydro employees, which at the present time is being placed before the local Commissions.

Mr. Ellis was endowed with talents specially fitted for public service. From the early days of "Hydro" in Ontario he gave unstintingly of his time and effort to further this movement. He was gifted with a capacity for detail and exercised over many features of the work of the Commissions with which he was associated a personal supervision that contributed to efficient operation. He was possessed of a real zeal for public ownership and manifested a high sense of public responsibility, often exerting himself on behalf of public service at

the sacrifice of time and effort which might have been devoted with personal profit to other interests.

Those who recall the efforts that had to be put forth a quarter of a century ago in connection with the general program of public ownership in Ontario will appreciate that it required special enthusiasm and courage to take such a stand at that time. Mr. Ellis was one of those in the forefront of these early efforts. Although Mr. Ellis's main efforts were contributed to the advancement of the interests of the City of Toronto, yet the general interests of the municipalities of Ontario were not forgotten whenever his influence could be exerted upon the side of any cause being sponsored in the general welfare of the citizens.

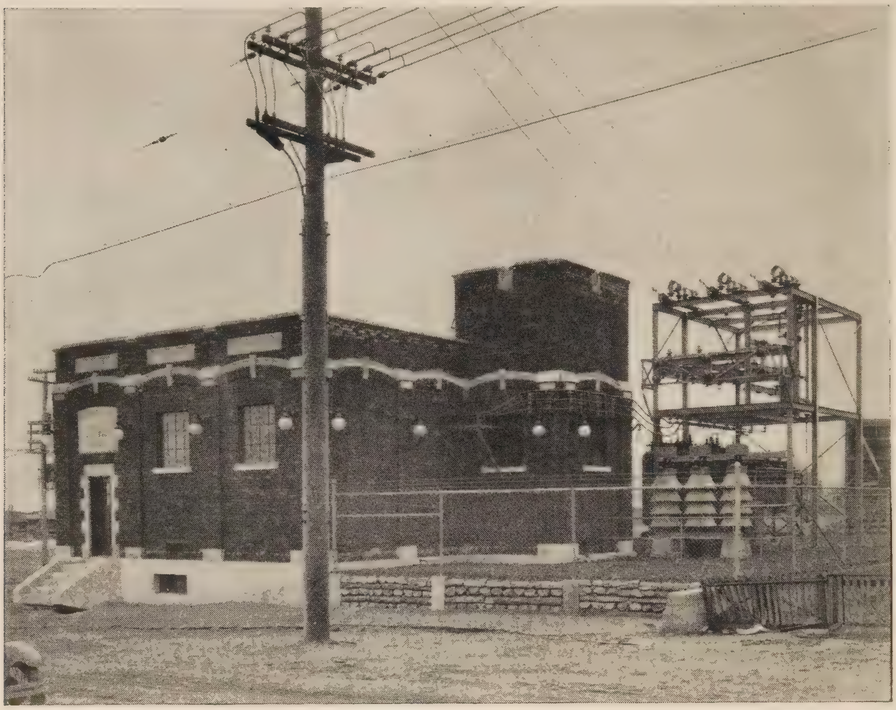
Mr. Ellis had a ripened experience begotten of personal contact and long service, together with an intimate knowledge of personnel and historical background, and in this respect alone his passing cannot fail to be a great public loss. He was a splendid citizen with a fine sense of responsibility, approachable and ever ready to co-operate. He was possessed of vision and, as has been well said, was 'a forward-looking man'.

It is needless to add that the passing of Mr. Ellis came as a great shock to all who knew him and widespread and sincere sympathy has been expressed to the members of his family in their great loss.

Cameron Street Substation, Port Arthur

By T. W. Brackinreid, Manager, Public Utilities Commission, Port Arthur

THE domestic and commercial lighting loads, as well as that of the Street Railway having reached a magnitude, that additional sub-station transformer capacity was found necessary, it was determined to provide a new sub-station which would be located as close as possible to the load centre of the down town district. Port Arthur is served from the Cameron Falls development of the Commission's Thunder Bay System, over three transmission lines operating at 110 kv., with transformation at Bare Point at the extreme east end of the city from 110 kv. to 22 kv. Four 22 kv. outgoing feeders from the Bare Point Terminal Station distribute power throughout the city, all of which centre at the High Street Sub-station, enabling the latter to be fed from any two of these four feeders. As High Street was the distribution centre for all outgoing 2300 volt lighting feeders and 550 volt street railway feeders, supplemented to a very limited extent by a small hydro-electric generating plant at Current River, of about 2000 h.p. capacity, and as the High Street transformers were considerably overloaded, the Cameron Street site was chosen as the proper location for the new



Cameron Street Substation, Port Arthur

station. By locating this new station close to the main business district of the city, and by providing for automatic and remote control, it was possible to accomplish a considerable saving in feeder copper as well as to eliminate any increase in labor charges for station operation.

The Cameron Street station has a capacity of 3000 kv-a. of stepdown transformers and is fed from a 22,000 volt line which, by switching equipment installed outside of High Street Station, can be transferred to any one of the four 22,000 volt feeder circuits which originate at Bare Point Station.

This bank of transformers steps down the voltage from 22,000 volts to 2300 volts for local distribution.

The transformers and high tension equipment is of the outdoor type and consists of high tension structure, high tension oil circuit breakers, transformers and lightning arresters.

The 2300 volt secondary is carried into the building to the 2300 volt low tension bus where it is fed to the distribution system through suitable feeder oil circuit breakers.

The building is of cement, brick and stone construction and is approximately thirty-two feet square. It is heated electrically and the heaters are controlled automatically by thermostats, the temperature being held at any desired point.

The lighting is controlled by a time switch that is equipped with an astronomical dial. This dial is set to sun time and no further change is necessary in the setting, the lights

going on and off in accordance with the length of the day.

The equipment in the station consists of nine panels as follows :—

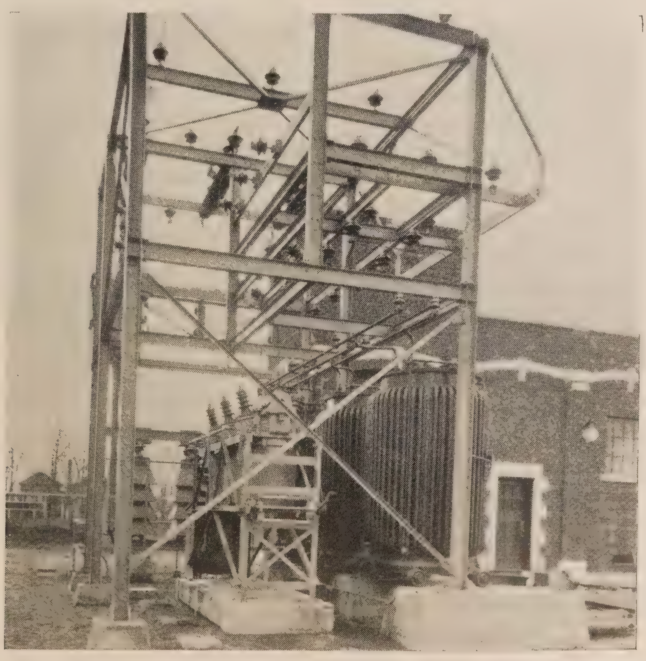
Incoming Line Panel
Station Service Panel
Main 2300 volt Bus Panel
Auxiliary 2300 volt Bus Panel
4 Reclosing Feeder Circuit Panels
1 Contactor Panel

The incoming line, station service, main and auxiliary 2300 volt bus breakers which are also mounted in this station are supervisory controlled from High Street Station.

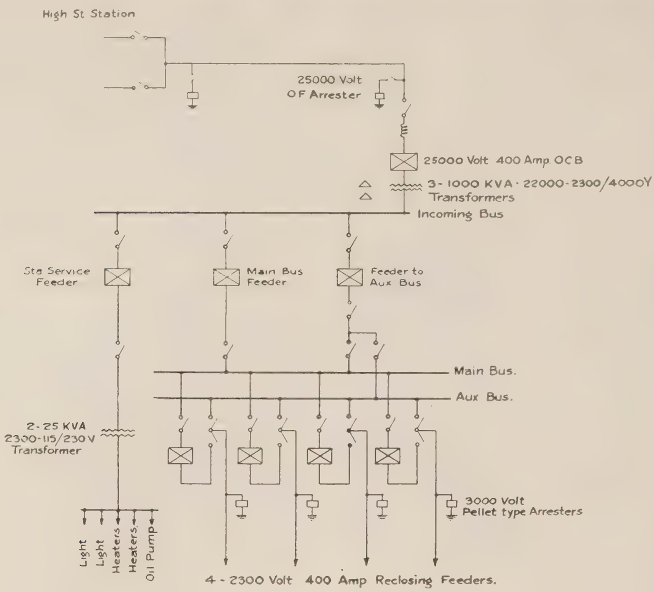
The feeder breakers are of the reclosing type and when tripped out due to trouble on the line, reclose three times at intervals of thirty seconds, providing the trouble still exists, and then lock out. The signal is given at High Street Station and the breaker must be closed from Cameron Street Station if the trouble is clear, and the reclosing feature is then re-set for further operation. If the breaker stays closed after one or two operations, the timer mechanism operates to a point where it is ready to reclose the breaker three times.

At High Street Station it was necessary to install storage batteries to supply direct current for the supervisory control, with panel to control same, panel for metering the load at Cameron Street Station, together with the necessary instrument transformers, also panel on which is mounted necessary control button, relays and lamps for operating and signalling for the control.

The supervisory control system used is of the cable type and a 25 pair telephone cable connects the High



View showing outdoor switching and transformer installation.



Substation wiring diagram.

Street and Cameron Street stations for this purpose.

The description of this cable type supervisory control is as follows; and has been designed for one dispatcher's station and one remote station :—

The dispatcher at the control station is able to perform the following operations at the remote station:-

(1) Open and close one transformer high tension oil circuit breaker

(2) Open and close three 2300 volt oil circuit breakers

The following indications will be made at the control station by means of red and green lamps :

(1) Open and closed position of one transformer high tension oil circuit breaker

(2) Open and closed position of three 2300 volt oil circuit breakers

(3) Locked out position of four automatic reclosing feeder equipments

The supervisory equipment located in the Dispatcher's station consists of the necessary keys, lamps and other apparatus mounted on a panel. The key and lamp panel is equipped with one, two position control key and three indicating lamps (red, green and white) for each oil circuit breaker supervised.

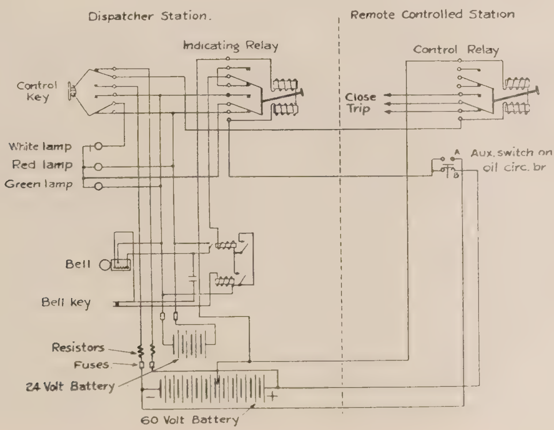
The supervisory equipment located at the remote station consists of the necessary supervisory relays and auxiliary relays to connect the control circuits to the devices supervised.

Whenever the Dispatcher desires to operate any oil circuit breaker in the remote station he merely turns the key controlling that unit, after which the operation is automatic.

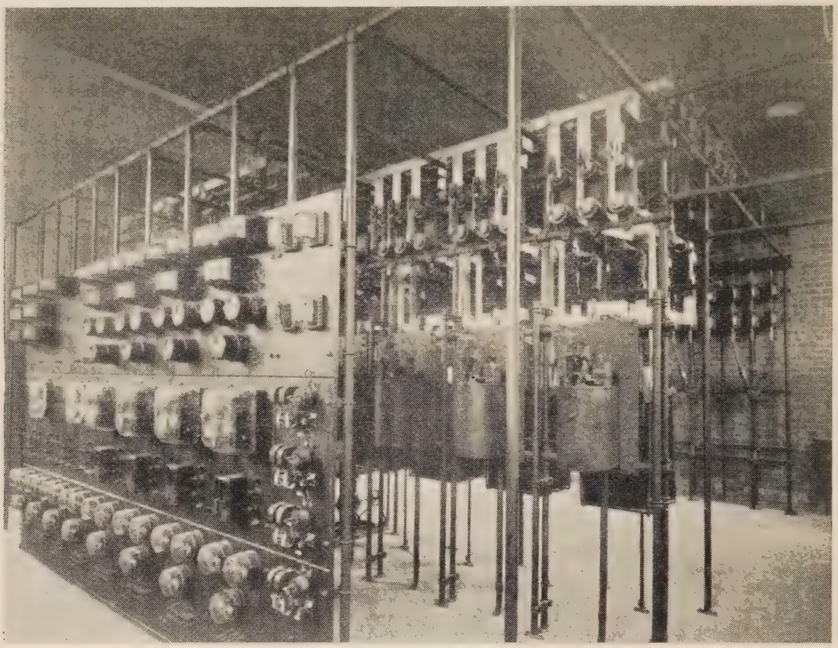
The green lamp associated with each control key remains lighted as long as the remote station unit controlled by the respective key remains open, the red lamp remains lighted as long as the remote station unit controlled by the respective key remains closed, and the white lamp remains lighted as long as the position of the control key does not agree with the position of the remote station unit. Thus, when the Dispatcher turns a control key the corresponding white lamp is immediately lighted. When the operations are completed the white lights are extinguished and the green and red lamps change to correspond with the position of the supervised devices. Should a control operation fail to be completed the corresponding white light will not be extinguished.

When a supervised unit at the remote station is opened by a protective device or from some cause other than in response to the Dispatcher's signal, the red and green lamps change to correspond with the position of the breaker, and the white lamp is lighted. Audible indication is also given by an alarm bell. The Dispatcher, upon noting the change, may extinguish the white light by turning the corresponding control key so as to agree with the position of the supervised unit. The alarm bell is controlled by a separate two position key. With this key in one position the bell gives one stroke, but in the other position the bell rings continuously when a change in any indication occurs. With this key in position for a continuous ringing the Dispatcher may silence the bell by turning the key to the single stroke position. He may then turn the key back to the position for continuous ringing for future signals.

The control impulses of the cable supervisory system are transmitted over separate conductors from those over which the indicating impulses are transmitted so that it is impossible for indicating signals to interfere with control operations.



Elementary diagram of supervisory control showing dispatcher's station and one remote controlled station.



Switchboard and 2300 volt circuit-breaker and feeder equipment

The supervisory system indicates by means of lamps the lockout position of the four automatic reclosing feeder equipments. No provision is made for the remote control of these four feeder oil circuit breakers.

Correction

In the March BULLETIN, pages 66 and 67, the capacities of the Trethewey Falls and Elliott's Chute plants were given as 2400 h.p. each. The former should have been stated as 2300 h.p. and the latter 1800 h.p.

"Every engineer must be a specialist to some extent, but the man who meets the famous definition of a specialist by 'knowing more and more about less and less' is no longer the object of universal veneration. Engineering cannot free itself from human relations, from business, or any great element of our national life. If the engineer cannot fit his work into the economic and social fabric of his times, it ceases to have any significance except as a pastime or form of self-punishment, as the case may be.

"It is a hopeful sign that engineers are turning from a mere tolerance of economics to a realization of the fact that business considerations are the core of every engineering problem."

—*World Power.*

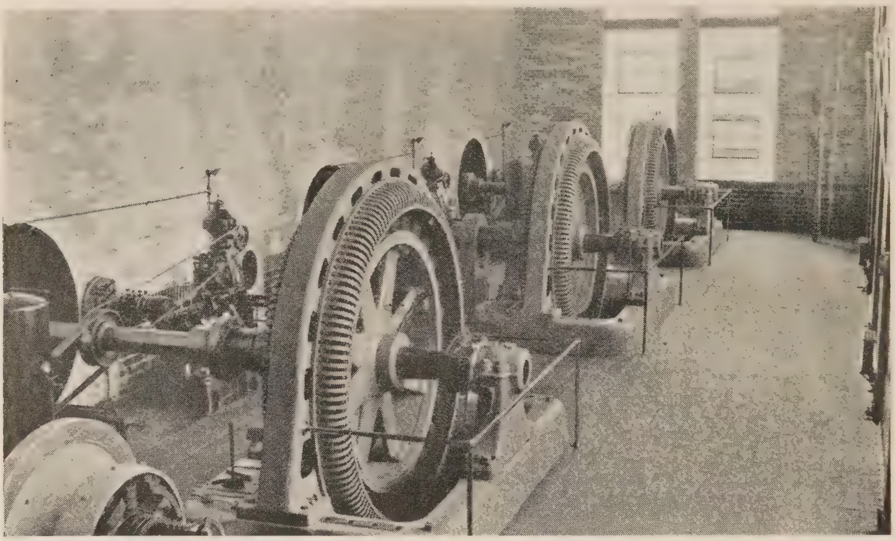
Orillia Commission Celebrates

ON the evening of Thursday, February 14, 1929, the Orillia Water, Light and Power Commission tendered a complimentary banquet to the other civic bodies of the town to mark the final payment on the first debentures issued in connection with Orillia's power plant.

In 1898 the Town Council proposed installing a hydro-electric plant on the Severn River, and after securing figures and information passed a by-law in February, 1899, for a debenture issue of $75,000.00 to extend over a period of 30 years. The principal and interest payments were equivalent to the fuel cost of the steam plant then operating, which was loaded to full capacity.

The construction of the new power plant was started in the summer of that year, and on January 21, 1902, the power was first turned on. The plant was handed over to the town on March 25th of the same year. This plant was constructed at Ragged Rapids on the Severn River. The first dam constructed, known as the Patriarch Dam, went out on April 7, 1904. A second dam was contructed, known as the Battle Dam, which was completed in July, 1905, at a cost of $28,000.00. In 1906 a third dam was begun, which was completed in 1908 at a cost of $75,000.00. Work was commenced on a new power house at Ragged Rapids, in 1911, soon after which Government engineers suggested removal to Swift Rapids, a

Orillia Water, Light and Power Commission's power house at Swift Rapids, Severn River



Generators in Orillia's Swift Rapids plant

little farther down the river. A new dam and power house were constructed at Swift Rapids by the Department of Railways and Canals and on November 17, 1917, the first current was received from Orillia's Swift Rapids plant.

The generating equipment at Swift Rapids consists of three 1500 kv-a. generators, driven by three water wheels of 2,120 h.p. each.

The total debentures issued by Orillia on account of power plant, transmission lines and distribution system, amount to $552,000.00, although the present debenture debt is but slightly over $255,000.00. All payments on account of capital cost and operation, from the beginning, have been paid out of earnings of the plant, nothing having come from general taxes.

The personnel of the present Commission is—Messrs. F. H. Horne, Chairman; J. C. Miller, the son of Mr. C. J. Miller, who was Reeve in 1898, Vice-Chairman; J. B. Johnston, Mayor; Commissioners, J. B. Tudhope, who was Deputy Reeve in 1898, and Peter Ritchie, who was superintendent of the old steam plant; F. Gover, Secretary-Treasurer, and R. H. Starr, Engineer.

Rural Hydro Electric Service

What it Costs and What it Does

DURING February of this year the *Brockville Recorder and Times* published a series of articles under the above title, written by Mr. J. E. Mackay, a user of Rural Hydro near Brockville. As these treat of the subject in different manner from that followed in previous articles given in this publication, and the author not belonging to the Commission, we take this opportunity of reproducing them.

In view of the projects already undertaken or proposed for extension of rural hydro-electric service in Leeds county, the *Recorder and Times* feels that the presentation of information as to the varied uses, advantages and costs of electricity for farm purposes would be of value and interest to many of its readers. A number of articles have been prepared accordingly describing concrete cases of farm use of electricity in other parts of the province under the Hydro-Electric Commission of Ontario and these will appear from time to time. It is hoped that they may serve to give a basis of information to persons on the lines of existing or projected service and contemplating the advisability of signing a contract; and, also, others who might expect additional extensions to put hydro light and power within their reach.

Basis and Form of Charge

Most prospective consumers of hydro-electric power are familiar with the provision which demands that three consumers per mile are necessary before construction of a line to provide light and power will be undertaken by the Hydro Electric Power Commission of Ontario. It is probable, however, that all are not familiar with the precise applicability of this regulation. It may be pointed out, therefore, that it does not mean that there must be three consumers in each and every mile, but that for the full length of line, treated as a unit for the purpose, there must be an average of three consumers per mile.

Thus, on a projected line seven miles in length, contracts must be obtained from a minimum of 21 prospective consumers. It makes no difference where consumers are located, whether in groups or evenly spaced along the line. The whole line is treated as a unit. Additional consumers over the minimum number contribute to the lowering of service charges and consumption rates along the full length of line—not on the particular mile or section on which they are located.

Charges are of two forms—a service charge at a fixed rate per month and a consumption charge divided into a first and second rate for kilowatt-hours used.

The service charge is determined by the cost of construction of the line, the number of consumers and the class of service taken. The cost of lines vary in different districts according to natural conditions. Thus setting poles in rock will heighten the cost as compared with setting them in soil. The province pays 50 per cent

of the cost of rural lines and secondary equipment—the initial capital investment—and its participation then ceases. The service charges are established at a figure to repay the consumer's share of the balance of cost over a fixed period of time.

From this it will be apparent that the greater the number of consumers on the line the lower will be the proportionate share of each consumer. The lowering of service charges may not be precisely equivalent to an increase in consumers, however. With an average of six consumers per mile instead of three the service charge for each of the six will not fall to half the amount which would be paid by each of three. Additional consumers entail certain additions to the capital outlay which make the calculation of reductions in service charges a matter of more than simple arithmetic. But, while the doubling of consumers will not cut service charges in half, it will reduce these charges very greatly. Every additional consumer helps to lower service charges until the full capacity of the line is reached.

It should be noted, however, that the service charge is not the same in amount to all consumers along the line. It varies with the class of service given them. This difference in classification for service charges does not alter, however, the foregoing statement that increase in number of consumers lowers service charges. It serves to illustrate the impossibility of reaching a conclusion as to reduction in charges by simple calculation from the amount of increase in consumer numbers. In each service there is a limitation as to the appliances which may be used; the service charge increasing as the range of use permitted widens. As contrasted with consumption rates, the service charge must be paid after a contract has been entered upon whether there is any use of service or not. It becomes a charge against the property concerned and remains until the line is paid for.

Consumption rates refer to the actual use of electricity. There are two consumption rates—a first and higher rate, applying on a fixed first amount of consumption, according to the class in which the consumer falls, and a second or lower rate, for all consumption beyond that amount. Most farmer consumers in this district would fall within Class 3 in which the first rate applies on a consumption up to 42 kilowatt-hours per month or 126 kilowatt-hours for the three months period for which bills are rendered. The second rate would apply on any excess over 126 kilowatt-hours. As in the case of service charges the consumption rates will be influenced by the amount of consumption on the whole line. The line is designed for a certain supply capacity and the cost of using it to this point increases very slightly beyond its fractional use. Enlarged consumption within its capacity makes possible the lowering of kilowatt-hour rates.

Classes of Service

Contracts for service in rural power districts fall under 12 classes. Each of these classes has certain limitations as to use of service. There are two classes of hamlet lighting, one each of house lighting, small farm service and light farm service, two of medium

farm service, heavy farm service and special farm service and one for syndicate outfits. Each class is designed to meet certain requirements of consumers and a knowledge of the different classes which might be chosen for their requirements is worth while for those who wish to decide wisely the type of service likely to be of most value to them.

There is a different service charge for each class ; also a variation in the amount of consumption to which the first, and higher consumption rate applies. All new rural power districts begin at standard rural rates. The highest rate, or 100 per cent. of standard, is quoted as the service charge for each class in the description which follows. It should be remembered in connection with these charges that prompt payment of bill reduces them by 10 per cent. Further, that service charges are reduced as operating conditions warrant. While the first rates are likely to be as quoted, in the second year they might be lower.

The two classes for hamlet lighting include service in hamlets where four or more consumers are served from one transformer. Farmers and power users are excluded from these. The first class (1B) is for service to residences or store. Use of appliances over 750 watts permanently installed is not permitted under this class. The second class (1C), also to residences or stores, permits electric range or permanently installed appliances greater than 750 watts. In the former class the service charge for a new line is $1.80 per month and for the second $3.30.

The third class (2A) is for house lighting service to all residences that cannot be grouped as in the previous classes. It excludes farmers and power users. The service charge on this at $2.25 as compared with $1.80 on class 1B illustrates the advantages to be obtained by service of several consumers from one transformer.

Class 2B, the fourth, applies to small farms of ten acres or less in vegetable or fruit growing districts and 50 acres or less in mixed farming districts and provides for service for lighting of buildings, power for miscellaneous small equipment and for a single phase motor not exceeding 2 horse-power or an electric range. Where both motor and electric range are employed they may not be used simultaneously. The service charge for this class is $3.45 per month.

In each of the foregoing classes the first kilowatt-hour rate of the consumption charge would apply on consumption up to and including the first 30 kilowatt-hours per month. The difference in charges on these classes is found therefore, in the service charge.

Most farmer users would fall within the next grouping, Class 3, for light farm service. This covers service for lighting of farm buildings, power for miscellaneous small equipment and for single-phase motors not exceeding three horse-power, and for an electric range. As in class 2B, the range and motor may not be used at the same time. Service charge for this class rises to $4.55 as compared with $3.45 in the previous class, while the first kilowatt-hour rate applies on consumption up to and including

42 kilowatt-hours as compared with 30.

Class 4, described as medium farm service one-phase, is similar to class 3 except that it provides for the use of motors up to five horse-power. The service charge at $4.75 is only slightly higher than for the previous class. Class 5, also medium farm service but three-phase, provides for the same uses of service as the preceding class but permits the use of three-phase motors up to five horsepower demand. The service charge for this class rises a dollar to $5.75. In both these classes the first kilowatt-hour rate applies to consumption up to and including 70 kilowatt-hours per month.

Heavy and special farm service classes will be of interest to only a few consumers who can use more power than is required ordinarily on the farm. In addition to service for lighting and power for small equipment, each has a different allowance for size of motor and use of electric range. Class 6 provides for motors up to five horsepower demand and an electric range or for motors up to 10 horse-power without an electric range. Single or three-phases service is given at the discretion of the commission and the service charges are adjusted accordingly at $7.35 or $8.30 The first kilowatt-hour rate applies on a monthly consumption up to and including 126 kilowatt-hours. Class 7 provides for motors from 10 to 20 horse-power demand and an electric range with single or three-phase service and service charges at $10.90 or $13.20. The first rate for consumption applies for an amount up to and including 210 kilowatt-hours.

A final class for syndicate outfits provides for a special arrangement for joint operation of outfits by existing consumers who may form a group for this purpose. The requirements are that the total of the relative class demands of those who wish to form a syndicate shall be not less than the capacity of the syndicate motor. Thus a group of consumers with contracts in any of the foregoing farm classes whose total class demands equal 20 horse-power may get a syndicate contract for use of a motor up to that demand. This provides a valuable opportunity for co-operative action in carrying out operations for which the power requirements may be much beyond those of the class of any single consumer. Such may be found in threshing and silo-filling.

While most consumers in this district will fall within the hamlet lighting and light farm service classes, the outline of the other classes indicates the various uses of power for which provision is made. It will be noted that for each class the service charges vary. The reason for this variation will be found in relation to the form of service. The higher power service involves greater capital outlay to give this service to the particular consumer concerned.

This variation suggests also why an increase in consumers may not result in a decrease in service charges exactly proportional to this increase. The effect of an additional consumer can only be determined by precise calculation in relation to the existing situation on a particular line.

The service charge has been shown as a definite charge for the provision of service and varying according to the class of service. Its purpose is the repayment of capital cost of the

line and the equipment necessary for the class of service. It has been pointed out that as consumers increase above the minimum number the share of each towards repayment of this capital cost can be reduced, although the new cost of installations to provide for the required class prevents this reduction from being equivalent to the increase.

The consumption rate has been shown as a charge for actual use of electricity. It is divided into two rates. The first rate for a specified amount of consumption is higher than the second. This is based on the fact that after delivery of a certain amount of electricity the delivery of an additional amount involves a much lower cost. With sufficient consumption to use the line near its full capacity the first charge and also the second can be lowered, as has occurred on many lines elsewhere. In this respect, the rates may be compared to freight rates for less than car-lot and car-lot shipments on a railway, or to retail and wholesale prices.

How do these charges apply ?

The explanation may be given by concrete illustration, using the service charge and consumption rates at which all new rural power districts begin.

Let us take the case of a consumer in Class 3 (Light Farm Service) whose meter at the end of the three months period when billing is usually made for rural lines shows a consumption of 135 kilowatt-hours. The service charge for Class 3 is $4.55 per month or $13.65 for three months and consumption rates are 7 cents for the first 42 kilowatt-hours per month or 126 kilowatt-hours for three months and 2 cents for all additional con-consumption. This consumer's quarterly bill would show the following :

Service charge, (3 months)	$13.65
Consumption charge (on total 135 kw-hr.)	
First rate, 126 kw-hr. at 7c.	8.82
Second rate, 9 kw-hr. at 2c.	.18
Gross bill	$22.65
10% prompt payment discount	2.26
Net bill	$20.39

The cost of electricity in this case would thus be slightly less than $7.00 per month.

In this example the consumption was not of amount to fall to any extent within the second and lower consumption rate. It is interesting to note that if consumption had been double this amount, that is, 270 kw-hr. instead of 135 kw-hr., the net bill would have been only $2.43 greater. In other words, 100 per cent. increase in use would have cost only 11.4 per cent. more. His quarterly bill would have been as follows :

Service charge (as before)	$13.65
Consumption Charge,	
First rate, 126 kw-hr., 7c.	8.82
Second rate, 144 kw-hr., 2c.	2.88
Gross bill	$25.35
Prompt payment discount	2.53
Net bill	$22.82

Although obtaining double the amount of lighting and power service the consumer in this latter illustration would pay only about 82 cents more per month.

These illustrations, in addition to showing how charges apply in the quarterly bill, indicate the importance of having enough consumers to obtain

a reduction in service charges and a volume of consumption to lead to reduction of the first consumption rate. They show also how the existing consumer by enlarging his use of the service within his class gets additional consumption at a relatively low cost after using an amount at a higher rate. A general advantage to all consumers accrues in a similar way for larger use of the line as a whole.

From this consideration of the working of rates the thought of the prospective consumer turns naturally to the question of what is obtained for this expenditure.

Some Actual Uses of Hydro Service

It is only by a study of the possible uses of hydro service with the comfort, convenience and economies of these uses in relation to their cost that a satisfactory conclusion can be reached as to its advisability in any particular case. Such study may be made best through examination of the experience of actual consumers of hydro service. The following illustrations, obtained from The Bulletin, published by the Hydro-Electric Power Commission of Ontario, are examples of actual experience.

Example in Class 3.—This deals with a consumer in Class 3, light farm service, living north of Woodbridge, who obtained service on an extension of the service in 1924. In this case the service is used for lighting in house, barn and other buildings and in yard, making a total lighting installation of 1860 watts, and for iron, washing machine, automatic water system, driving a one horse-power motor on deep well for barn uses, a three horse-power motor on chopper and one-quarter horse-power motor on direct belted cream separator. The latter uses bring the total connected load to 6,002 watts.

House use of the service is for the ordinary requirements of a family of six. Besides lighting it provides water service, including that for a bathroom and is used to operate the washing machine and electric iron for the laundry needs of the family. In the barn, besides lighting, power is used for chopping about 400 hundred-weight of chop per year, separating cream from the milk of 11 cows which takes 20 minutes each time, morning and evening every day in the year, and pumping water from a deep well for 30 head of cattle, six horses and 25 pigs.

These uses cover a range which would meet very completely the requirements of the average farmer consumer. In this case the total consumption for the four quarters ending within 1927 amounted to 870 kilowatt-hours, and the net bill for these four quarters totalled $73.19, an average of $18.30 per quarter or $6.10 a month.

The service charge in this case was $3.85 per month, the first consumption rate for two quarters five cents and for balance four cents per kilowatt-hour and the second rate two cents. These charges are considerably below those on the inception of a new line, but suggest the decrease in rates possible under a general use of the service as obtains in the Woodbridge district. At the 100 per cent. of standard rates, which would apply, the cost of service for this consumption on a new line in the Brockville district would be $87.48

for the year an average of $21.87 per quarter, or $7.29 per month.

The prospective consumer in estimating the value of this service must balance up its costs against such factors as comfort, convenience, saving of time and labor in pumping water, separating cream etc. He must consider also the cost of equipment for these varied purposes, but as most of the equipment with proper care has a long life, this cost should be chargeable over a considerable number of years.

Example in Class 4.—This deals with a consumer in medium farm service, one phase, in a section of the Woodstock rural power district to which the line was extended five years ago at rates approximately the same as will be put into effect in the extensions near Brockville. The installation provides for good lighting in house and buildings, automatic water system caring for a bathroom and other water service equal to that of a town or city home, a five horse-power motor in the barn for chopping grain and pulping roots. Total installations in this case amount to 6,791 watts.

Total consumption on this farm for 1926 amounted to 948 kilowatt-hours. The service charge was $4.30, the consumption charge four cents for the first 70 kilowatt-hours per month and two cents for all additional. Net cost for the year amounted to $77.96.

For the same class on a new line in Brockville district the service charge would start at $4.75, the first consumption rate would be seven cents and additional consumption two cents. The cost of this consumption would amount, therefore,under these latter conditions to $106.16 after deduction for discount.

It is worth noting that most of this difference between the costs in the case cited and the estimate for a new line in this district is due to the higher first rate for consumption. Out of this consumption of 948 kilowatt-hours for the year, the first rate in this class applies on 840 kilowatt-hours for the year (70 per month) and the difference between a first rate of seven and four cents reaches $22.68 on the year's net bill. The difference in service charges—$4.75 and $4.30 per month–amounts only to $4.86net.

These figures may be compared usefully with the costs for a Class 3 service. The difference suggests the desirability of careful consideration, before taking a service, as to requirements and needs. The difference between Class 3 and Class 4 is in power of motor permitted; in the former class, motor not exceeding three horse power is permitted, in the latter motors up to five horse-power demand. But in the latter class the first consumption rate applies on the first 70 kilowatt-hours' use as against 42 kilowatt-hours in Class 3. This difference of 28 kilowatt-hours per month at the higher first rate reaches a considerable figure in the course of a year. Where class C service meets most of the requirements of a consumer and he might need only occasionally the greater power under Class 4, he might well consider means of adapting his work so that he could operate within the limits of Class 3.

The articles then treat of special applications of rural power service such as water supply, chopping, etc., which have been covered in previous numbers of THE BULLETIN.

The Protective Relay Installation at the Toronto-Leaside Transformer Station

By E. M. Wood, Electrical Engineering Dept., H.E.P.C. of Ont.

(Presented at the Annual General and General Professional Meeting of the Engineering Institute of Canada at Hamilton, Ont., February 15th, 1929.)

Continued from March number

Transformer Zone Relays

Fig. 4 shows the power wiring of a transformer zone in heavy lines, also the zone protection current transformers, secondary wiring and relays being shown in lighter lines.

Current transformers of suitable ratio and characteristics are placed on each bushing of every circuit breaker of the zone, on the bushings external to the zone so as to include the breaker in the protected area. Each breaker is in this way included in two elements of the station, thus taking care of breaker failures, by clearing the zone on either side.

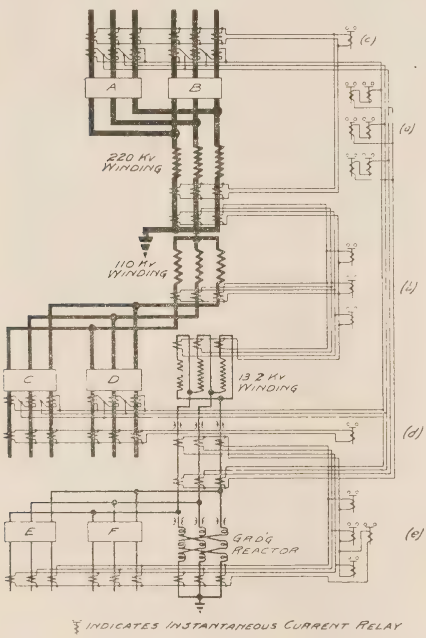


Fig. 4—Transformer Zone Protection Diagram.

The current transformer secondaries are connected differentially as shown, so that if the kilovolt-amperes leaving the zone is equal to the kilovolt-amperes entering it, no matter through what breakers it goes, the secondary currents circulate without passing through any relays.

A fault in the zone will create a difference between the kv-a. entering and leaving the zone, which will be represented by current in the relay circuits, and this can be made to trip circuit breakers. This is the principle on which all zone differential schemes operate.

This particular differential installation has the following interesting characteristics:—

(1) It includes circuits operating at three voltages, two of which are in star and one in delta. Moreover, on the 220-kv. side there are two 5 per cent. voltage taps, and on the 110 kv. side there is a load tap-changer which may be varied over a range of 15 per cent. voltage at will. In order to balance out under normal conditions, each primary kilovolt-ampere, no matter which winding, must have the same secondary current.

For this reason the current transformers are wound with turns corresponding to the amperes at a given kilovolt-ampere rating in the respective primary winding. The 220-kv. current transformers have taps which must be changed by hand when the bank taps are changed. The 110-kv. current transformers have taps which are changed by drum switches which rotate with the power tap changer mechanism. The change from star to delta is suitably taken care of in the current transformer connection as shown.

(2) When a transformer bank, especially at 25 cycles, is switched on to a live line, or when voltage suddenly recovers to normal value after being at low value, as on the clearance of a short circuit, there is a rush of magnetizing current to the bank which may be more than full load current, but which quite rapidly drops to normal magnetizing current. This rush of current into the zone is not balanced by any outgoing current and its equivalent therefore appears in the differential relay circuit. It has to be reckoned with in the relay settings, which must be given timing at lower fault currents.

On the other hand, a fault in a transformer often starts with very little current disturbance and develops gradually. It is therefore desirable that the transformer be disconnected as soon as possible for a comparatively small fault current to prevent spread of internal damage.

These two considerations in transformer zone relaying are somewhat conflicting. An inverse time relay of very low impedance, which would

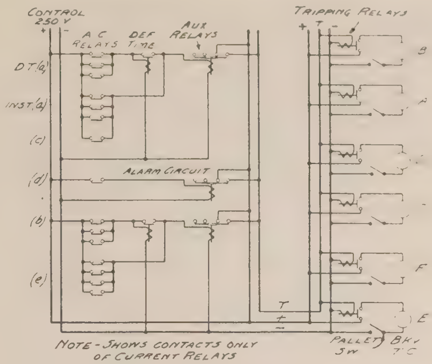


Fig. 5.—Transformer Zone Trip Circuit Diagram.

start at about 35 per cent. of bank rating, and would become instantaneous at about three times the bank rating, would be ideal for this purpose as it would give time clearance of incipient faults, would be fast on heavy faults and would permit the bank to be "picked up."

(3) There are six, and may later be eight, sets of current transformers in parallel on the zone breakers. Four at least of these are of the low ratio bushing type with weak characacteristics and high magnetizing current requirements even at low secondary voltages. The relays, therefore, must have the lowest possible impedance.

(4) For the parts of the zone which do not include the bank itself, the relays may and should be instantaneous.

We were unable to obtain an induction relay with suitable characteristics which could be given a minimum setting as low as desired and with anything like low enough impedance for use with the number of current transformers. We used in place of it the following combination of relays

which gives the desired characteristics:—

(*a*) On the whole zone, for phase to phase faults, one set of instantaneous current relays set at about two or three times the bank rating. These will take care of external faults with moderately heavy generator capacity connected, and also of heavy internal faults.

One set of relays timed about 0.6 to 0.8 seconds set at about bank rating for medium faults. These will be operative down to minimum connected generator capacity. These relays have fairly high current settings and consequent low impedance, so that the combination can be used with all the current transformers in parallel.

(*b*) On the bank itself, using one current transformer on each winding with relays set at about 40 per cent. of bank rating at three seconds' time. The relays are of low impedance type, but of low current

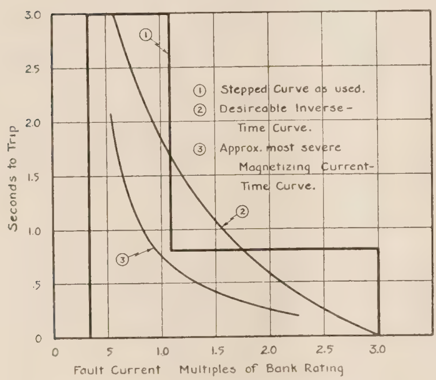


Fig. 6.—Relay Characteristics for Transformer Zone Protection (Including Bank).

setting, so they have fairly high impedance. However there are only three current transformers in parallel so the combination is satisfactory.

The combination of (*a*) and (*b*) covers the bank itself with a protection with a stepped curve as shown on fig. 6 which is considered satisfactory.

(*c*) On the 220-kv. wiring, a differential is arranged from the breakers to the transformer neutral with one instantaneous relay to take care of grounds on the 220-kv. station connections.

(*d*) An instantaneous differential for grounds on the 110-kv. part of the zone, similar to (*c*).

(*e*) An instantaneous differential for phase-to-phase faults, as well as grounds on the 13-kv. part of the zone. This has to take care of the 13-kv. grounding reactor which is done in the way shown on the diagram.

These relay groups trip a master relay, which in turn operates tripping relays so that all the six or eight zone breakers are tripped simultaneously. The connections for this are shown in fig. 5. The master relay also carries extra contacts for operating an alarm.

Condenser Zone

The details of this will be along the following general lines.

The condenser neutral will not be grounded, as each 13-kv. unit will be grounded through a zig-zag reactor connected to the transformer bank.

A differential will be installed to cover the whole zone from the two

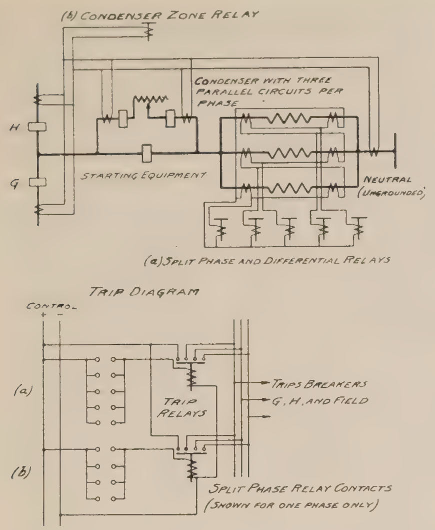


Fig. 7.—Condenser Zone Wiring Diagram with Protection. (Shows One Phase only).

13-kv. ring breakers to condenser neutral for phase faults and ground faults. In this, provision will have to be made to take care of the use of the auto-transformer in starting. This protection will be instantaneous, using current relays and current transformers outside the zone on the ring breakers and on the condenser neutral.

There will also be a split phase protection on the condenser windings. Each phase is wound in three parallel circuits, which will be balanced against each other to detect turn to turn faults in the winding. This will be combined with a differential on the winding itself to allow a fully effective setting for any ground further than one coil from neutral.

A proposed diagram is shown as fig. 7. The relays are all instantaneous, and trip the condenser ring breakers and the field breaker.

The starting equipment for the condenser is of the automatic push-button-controlled type, so that bearing temperature relays, winding temperature relays, reverse phase and other features will be required.

110-KV. LINES—PILOT WIRE PROTECTION

110-kv. Lines to Bridgman Transformer Station.

Each line is equipped with pilot wire protection, which is really a form of zone differential protection.

The lines protected are on double-circuit towers, the conductors of each circuit being arranged vertically and with no transpositions. We have taken advantage of this in assuming that no short circuit will involve the top and bottom phases of either circuit without involving the centre wire in order to use a simple scheme, the diagram of which is shown as fig. 8.

Due to the fact that a very low current setting was required in order to operate satisfactorily with only one unit on the system at Queenston, and that the breakers and bushing current transformers were of three different designs and dimensions,

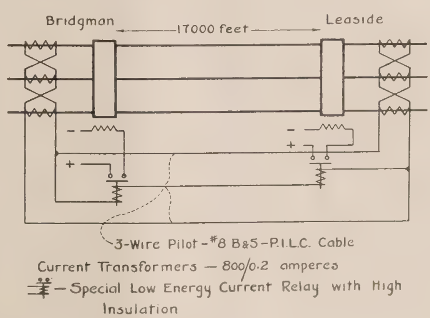


Fig. 8.—Pilot Wire Protection on Short 110 Kv. Lines. (Without Transpositions).

it was necessary in order to minimize the tendency to unbalance, to design special current transformers of 800–0.2 amperes ratio with 4,000 secondary turns also to design special low impedance, highly insulated relays.

The pilot, which is a three-conductor paper-insulated, lead-covered cable

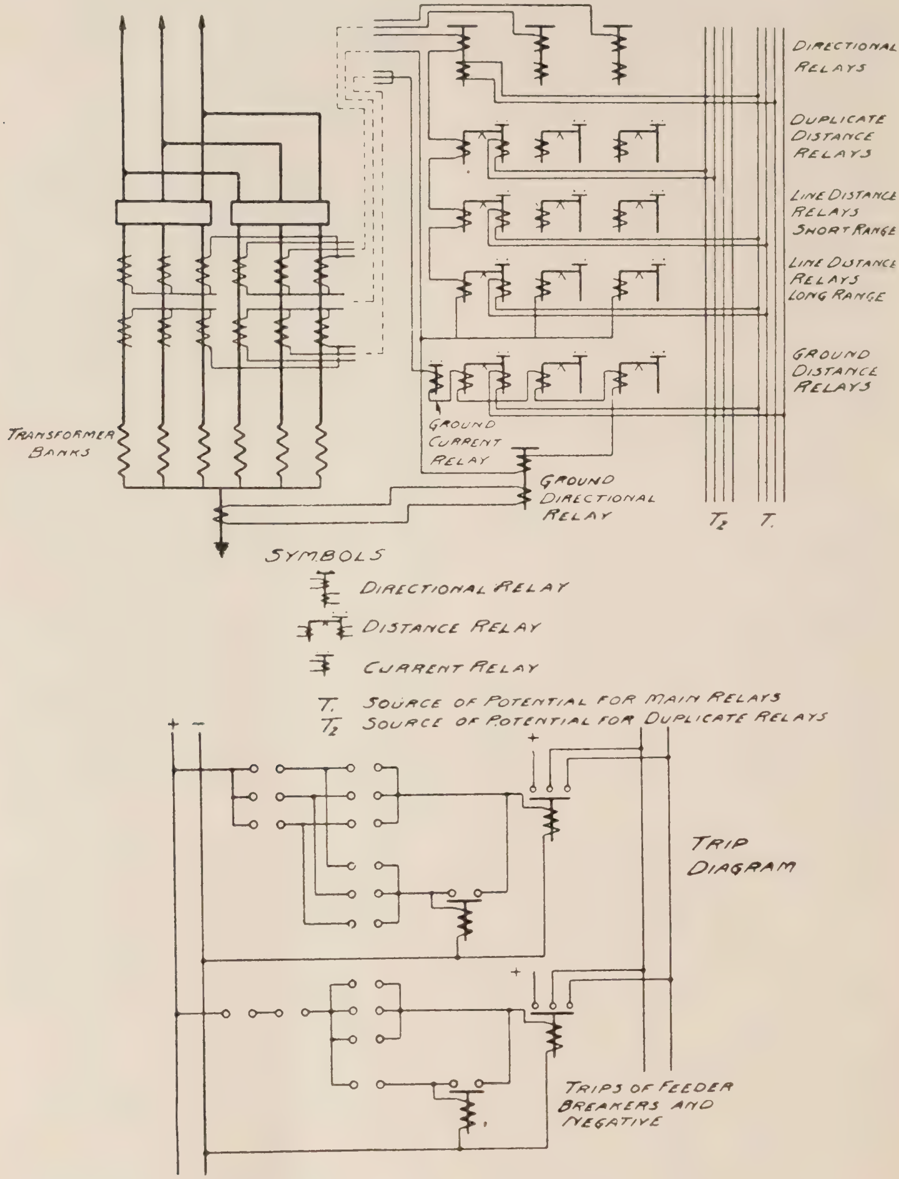


Fig. 9.—Typical Long Line Protection, Double Distance Range, Directional, with Duplicate Feature.

parallels the transmission line in a duct line and is subject to electromagnetic induction of some magnitude. Ordinary protectors, which operate by drawing off voltage to ground, cannot be used, as they would prevent the system from functioning when it is most needed. It was therefore decided to operate with the pilot relay system entirely isolated from ground.

This system opens the breakers on a defective line simultaneously at both ends very quickly for fault currents as low as 150 amperes.

220-kv. Line

At present there is only one 220-kv. line, but later there will be two and possibly more. Each line will be equipped at either end with the best protection possible for single radial operation. When two or more lines are in service this will be supplemented by a parallel line protection of the standard current balance type, for phase faults and ground faults.

Radial Line Protection

This is designed to clear instantly at one end at least any phase-to-phase or phase-to-ground fault on the system. It is also selective with the station zone protections so as not to give interruption for a station zone fault.

It is considered that while phase-to-ground faults are more common, provision must be made for simultaneous grounds on two phases, or phase-wire-to-phase-wire faults in this country where lightning and sleet are liable to be severe.

The phase-to-phase protection consists of directional double range distance relaying as shown in diagram in fig. 9 and consisting of:—

(*a*) One set of directional elements required to make the instantaneous line relays direction-selective with the Leaside bus protection. These use potential of the phase which lags behind the current.

(*b*) One set of instantaneous distance relays set with a three-phase distance range just short of the Paugan bus. These will be effective over about 75 to 80 per cent. of the line to Paugan and doubtful or slow over the remainder of the distance. They will positively not be effected by Paugan station faults or beyond. Paugan instantaneous relays are similarly set with regard to Leaside bus.

All phase distance relays use phase-to-phase potential leading the current.

(*c*) One set of distance relays timed 0.6 to 0.8 seconds to be time-selective with Paugan station relays, and with a distance range to be completely effective under all conditions to the end of the line.

(*d*) A duplicate set of distance elements only, with the same setting as (*c*), but using a separate source of potential. These relays are required on account of the small number of lines and the current setting of the relays below normal load value.

Ground Protection

Relays for ground protection all use ground residual current from the

neutral wire of the current transformer group. They comprise:—

(a) Ground directional relay using transformer neutral current as a direction reference current.

(b) A residual current relay. The trip current from this supplies the distance elements (c) and also a definite time relay timed at 0.8 seconds to be time selective with Leaside or Paugan station ground relays.

(c) A set of instantaneous ground distance relays using voltages from the respective phases to ground. The range of these relays is to be definitely short of Paugan bus. Due to inherent variations in phase-to-ground impedance these can probably not be made effective for over 50 to 60 per cent. of the whole length of the line. To this extent they are somewhat experimental and their operation is being closely watched and analyzed. We hope to be able to use them in double distance range like the phase relays. The ground relays are of special small, very low impedance type.

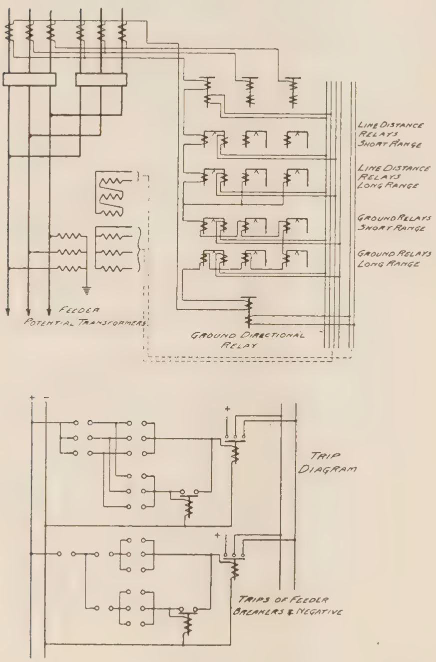


Fig. 10.—Typical Feeder, Double Distance Range Directional Protection on Phase and Ground, without Duplicate Feature.

The relays trip the respective line breakers.

The current balance protection on parallel lines, when such is available, will speed up the clearances somewhat on ground faults, but we believe the radial line protection in itself will give very satisfactory results. The combination will be selective by timing and direction with the zone protections at either end, and by distance range and direction with the 110-kv. systems. It will clear all phase-to-phase or ground faults at one end instantly, and at both ends instantly over the whole line except about 20 per cent. of its length at the end remote from the respective stations, in which case the timing of the relays is about 0.6 to 0.8 seconds.

The total relay, auxiliary and breaker opening time on a line fault was found in one case to be 14 to 15 cycles.

13-kv. Feeders.

The protection on these is of the directional double distance range type without duplicate feature as the setting is above the capacity of the cables, which are three 1,000,000 cir. mils, single-conductor, paper-insulated, lead-covered per feeder, with a maximum feeder rating about 15,000 kv-a.

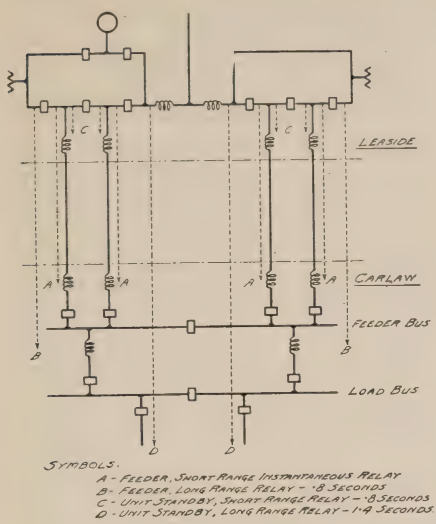


Fig. 11.—Feeder Diagram showing Distance Range of Relays.

In each feeder there are two current limiting reactances, one at each end, of 2½ per cent. on 15,000 kv-a. Between the Carlaw receiving bus and the load bus there is another reactor.

This system of reactors furnishes very convenient barriers to the range of phase and ground distance relays so that Leaside instantaneous relays can be made fully effective to the Carlaw reactors, but will not be affected by faults beyond that point.

The Toronto Hydro-Electric System end of the feeders is equipped with directional current phase and ground relays set practically instantaneous for feeder faults. The combination at the two ends assures clearance of any *cable* fault as fast as breakers can open.

Fig. 11 is a diagram of the feeders from two units showing the reactor arrangement and distance ranges of relays. The diagram of connections shown in fig. 10 is very similar in general principles to that used on the 220-kv. line, except that the double distance range is used for grounds as well as phase faults. This is allowable, as the cable system gives a definite impedance for grounded currents, whereas on open lines this impedance value is less certain.

Station Buses

The 13-kv. paralleling bus, and the 110-kv. busses after they are installed, will each be protected by an instantaneous differential current relay system supplied from current transformers on the remote side of each bus breaker and operating on phase-to-phase or phase-to-ground faults. The relays will trip all breakers feeding their respective busses.

Standby Relays.

These relays are installed to deal with the situation arising in case the instantaneous relays have failed to function completely, so that the fault is still on the system after a second or so. In such a case we must expect some inconvenience and loss of service, but we try to confine this to as narrow limits as possible by separating out the defective subsystem so that the sound subsystems can return to normal as quickly as possible. The defective subsystem, of course, is hopelessly lost, so that all that remains is to "kill" voltage and prepare for a fresh start.

Fig. 12 shows the various standby protections, and fig. 13 the tripping diagrams. The standby system is complicated by the fact that power may be taken from the station from any one or two of three windings.

The 13-kv. Standby Protection

A 13-kv. phase-to-phase fault

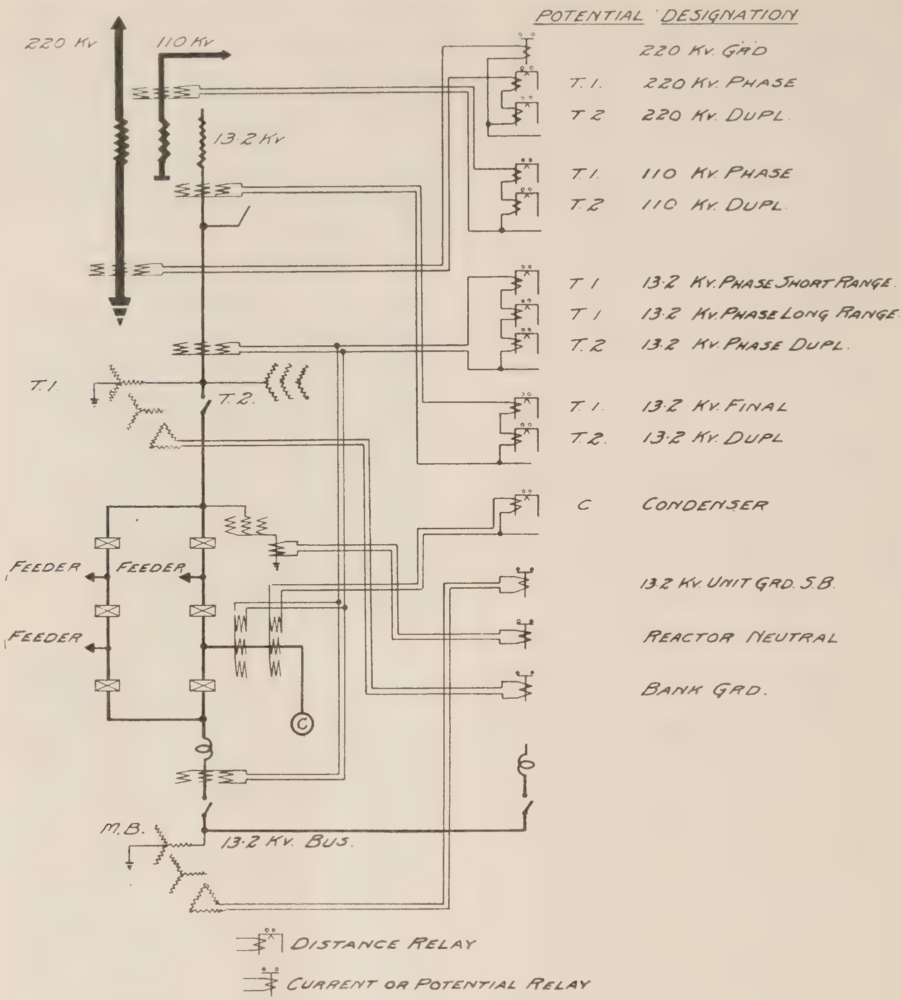


Fig. 12.—The Standby Relay Diagram Showing One Unit.

occurring at Leaside or in a feeder, or in a Toronto hydro station or feeders, may easily have sufficient magnitude to disturb seriously the voltage and stability of the whole system, and must be cleared from the system as quickly as possible. If the instantaneous relays at Leaside or the Toronto hydro station fail to accomplish this, we first endeavour to confine the trouble to one 13-kv. unit by means of what we call the "13-kv. unit standby." By paralleling current transformers of similar rating on transformer bank leads, condenser leads and bus leads, we obtain the total net input of current to the unit and its feeder group. We combine this with 13-kv. unit phase-to-phase potential in a double distance range group of relays as follows:—

One *set* of distance relays timed at about 0.8 seconds with a range well short of that of the feeder instantaneous distance relays to take care quickly of heavy faults in the Leaside station.

One set of distance relays timed at about 1.5 second, and with distance range to extend well into the Toronto Hydro-Electric system distribution system for more distant faults. These are time selective with Toronto Hydro-Electric system relays.

One *duplicate* set of distance elements only, of the longer distance range, using a second set of potentials, because the current setting of all these must be well below the normal rating of the unit, (45,000 kv-a.), to ensure action when several banks are in parallel at moderate load periods.

These relays all segregate the unit by tripping the transformer zone switches of the unit affected, (not of other transformer banks), the condenser zone switches of the unit, and the 13-kv. bus switches of all units.

It will be noted that on account of the manner of connecting the current transformers the relays operate on only those units which are hanging on to the fault.

If it does not clear the trouble, as might happen if the defective breaker is a 13-kv. bus breaker, a set of distance relays on each bank, using bank current and bank 13-kv. potential, operates in 2.0 to 2.5

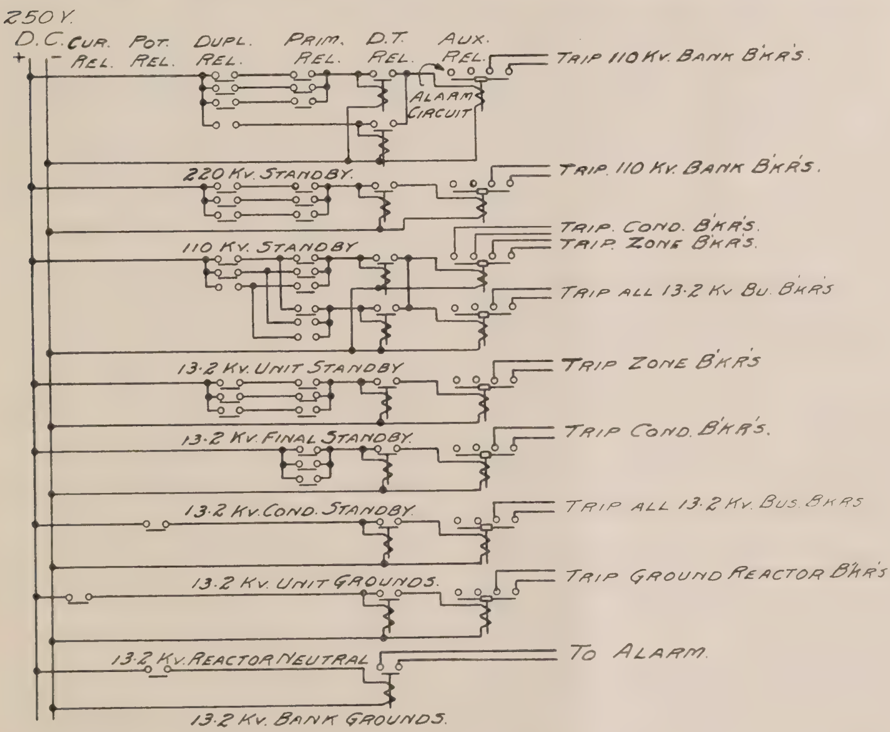


Fig. 13.—Standby Protections Trip Circuit Diagram

seconds to segregate, by tripping the transformer zone breakers, any bank which is still supplying current to the fault.

In case the condenser continues feeding to the fault, a set of distance relays using condenser current and potential operate to trip the condenser breakers and field in 2.0 to 2.5 seconds.

Grounds.

In case the fault is a single wire ground, the current is somewhat limited by the amount which the grounding reactors will pass, which is a maximum of about 1,500 amperes per reactor. A ground fault, however, is liable to develop into a more serious current or voltage disturbance and so must be cleared without unnecessary delay.

We first isolate the units from each other by tripping out all the 13-kv. bus breakers, using for this a potential relay connected, (as shown in fig. 13), to potential transformers on this bus. The timing of this feature is about 1.5 second. One unit at least is still connected to the fault, and we next use a current relay in the ground lead of the grounding reactor to remove the ground connection from the unit in about 2.5 to 3 seconds. This cuts the fault current down to charging current only and the arc may extinguish itself. If it does not, a potential relay similar to the one described above, but on the bank potential transformers, operates an alarm which rings until the operator has segregated the grounded element from the unit ring.

The 110-kv. and 220-kv. Standby Protections

If a fault on the 110-kv. system, or the 220-kv. system, fails to be cleared instantly, this will be evidenced by current passing through the bank from the other subsystem.

For a "back up" protection for such faults we use bank currents and corresponding potential for single range distance relays of long range which act really as overload relays for the respective winding. For 220-kv. grounds, the neutral current of each bank operates a current relay. As the current setting is well below bank rating to take care of the case when all banks are in parallel and minimum generator capacity is connected, the duplicate feature is used with each set of distance relays. These are all used to separate the Niagara system from the 220-kv. system.

Sources of Potential for Distance and Directional Relays.

Every distance relay requires a source of voltage for its potential coil which is proportional to the voltage of the circuit to which it is applied. The directional elements also require potential of the correct phase relation for their respective functions. The simplest method of obtaining these voltages is by means of potential transformers suitably connected to the line or bank to which the relay is applied. Potential transformers for 110-kv. or 220-kv. service become very expensive, especially in view of the fact that duplicate sources of potential are required in many cases. It was considered that some complication was acceptable if the very great expense of 220 kv. potential transformers could be avoided.

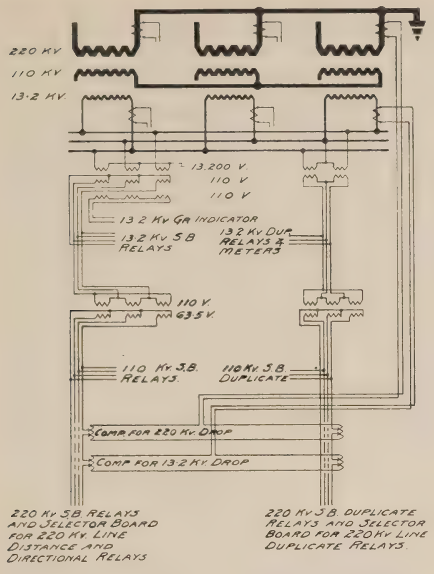


Fig. 14.—Sources of Potential for Relays.

A scheme was worked out for using potential transformers on the 13-kv. side as indicated in diagram in fig. 14.

On each 13-kv. unit the following potential transformers are installed:—

One set of three marked "*T*1" on 13-kv. lead of bank connected 13,200 grounded star to 110 volts star and 110 volts open-delta, (delta with one corner open).

One set of two marked "*T*2' on 13-kv. lead of bank connected 13,200 to 110 to 110.

One set of three on each feeder, marked "*F*," connected 13,200 grounded star to 110 star and 110 open delta.

One set of two on the *unit bus* marked "*UB*" connected V-V-V.

One set of two on the condenser feeder marked "*C*" connected V-V-V.

One set of three on the main bus of the station marked "*MB*", (one set for whole station),—connected grounded star to star to open-delta.

These are used in the following manner:—Feeder distance and directional relays are supplied from "*F*" set. The ground directional relay uses the open delta set of secondaries.

Condenser standby relays and condenser meters are supplied by the "*C*" set.

The 13-kv. unit standby and 13-kv. bank final standby relays are supplied from the bank sets, the main relays being supplied from *T*1 and the duplicate features from *T*2 along with the metering and instruments. The open-delta secondaries are used with potential relay for ground indication as previously described.

The *MB* and *UB* sets are used for metering and in connection with the unit standby when the infeed to the unit is from the bus only. The open-delta secondary of the *MB* set is used with the ground indicator of the unit ground standby for separating units as previously described.

All these applications are on 13-kv. circuits and present no particular problem.

In order to use these potential transformers to represent 110-kv. and 220-kv. phase-to-phase voltages we find that we have only voltages between line and neutral, also that these are incorrect by the amount of the voltage drop in the transformer windings.

To enable the 110-kv. and 220-kv. phase-to-phase voltages to be represented, we have added to each set *T*1 and *T*2, a set of small auxiliary

potential transformers rated 110 to 63.5 volts connected delta to star. The secondary phase-to-phase voltages thus obtained are considered sufficiently accurate for the 110-kv. standby relays main and duplicate, which are connected to $T1$ and $T2$ respectively.

For 220-kv. line and 220-kv. bank standby relays we require as high accuracy as can be obtained. To do this we compensate separately the $T1$ and $T2$ sets of potentials by adding vectorially to the potential transformer voltage, the impedance drops in the 13-kv. winding and 220-kv. winding of each transformer. This gives, with sufficient accuracy, voltages proportional to the 220-kv. line voltages under all conditions. The device used is the standard "*KX*" type compensator developed by the Westinghouse Company.

The compensated "$T1$" potential is used for 220-kv. bank standby relays and the "$T2$" for the duplicate. These are also available for the 220-kv line distance relays.

The 220-kv. line relays present an additional problem because they use line currents and must use bank $T1$ and $T2$ potentials. The operator must be free to switch any bank into or out of service, or the bank be free to trip out automatically without allowing the line to trip.

In this connection there are two sources of danger. The relays may

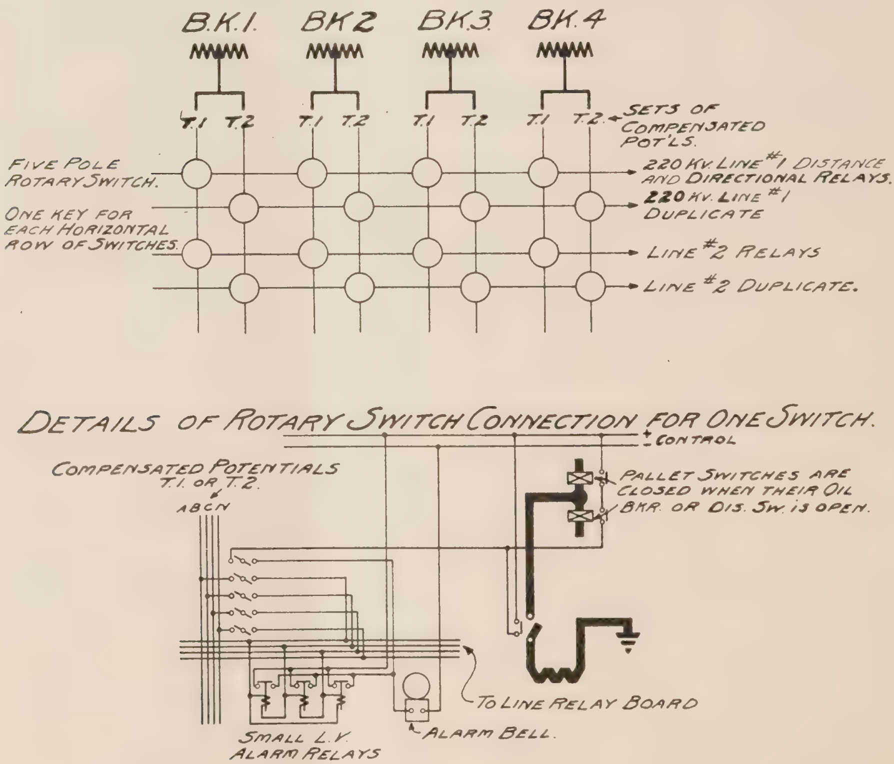


Fig. 15.—Potential Selector Scheme for Line Distance Relays.

be connected to the potentials of a "dead" bank in which case they become excess current relays set at less than load current and trip the line; or they may be connected to a bank which is alive from 110-kv. or 13-kv. side but not connected at 220-kv., in which case the relays would not be effective in case of a fault.

The duplicate set of distance elements takes care of the case when a bank has to be switched without notice, as the main and duplicate relays are connected to potentials from different banks.

A potential selector board, shown in fig. 15, was designed to enable the various bank potentials to be made available for 220-kv. line relaying. The main line distance and directional relays may be connected to any bank *T*1 potentials by means of a 5-pole rotary switch with a Yale cylinder. One key only is available and is left in the switch which is being used in order to prevent potential secondaries being connected together.

A similar set of switches enables the *T*2 potentials to be used with the duplicate set of relays.

In case the potential connected to a set of relays is dead a low voltage alarm will be sounded. If the relays are connected to a potential which is not connected to the 220-kv. an alarm circuit is set up through pallet switches on the transformer 220-kv. breakers and disconnecting switch and one pole of the rotary switch. The result is that if the potential connection is unsuitable an alarm rings, which can be stopped by switching over to a suitable potential.

It is believed that this arrangement will enable the operators to keep suitable potentials on the line relays and call their attention to any dangerous condition.

In conclusion, we would acknowledge the hearty co-operation of the Gatineau Power Company's engineers with those of the Commission in co-ordinating the diagrams of the combined systems, and the assistance of Mr. Paul Ackerman, A.M.E.I.C., who acted as consulting engineer on the combined system and who had developed the system of relaying and the types of relays used.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

A meeting of the Executive Committee of this Association was held at the office of the Hydro-Electric Power Commission of Ontario on the afternoon of Thursday, April 18, 1929, when the following were present:—Messrs., A. W. J. Stewart, Chairman, J. W. Peart, J. G. Archibald, J. R. McLinden, O. H. Scott, D. J. McAuley, A. L. Farquharson, J. E. B. Phelps, R. L. Dobbin, R. H. Starr, T. J. Hannigan, G. J. Mickler and S. R. A. Clement.

This meeting was called for the purpose of considering plans for the Summer Convention of the Association to be held at the Bigwin Inn on July 3, 4 and 5, 1929.

It was moved by Mr. R. H. Starr, and seconded by Mr. J. W. Peart, THAT the minutes of the previous meeting of the Executive Committee be taken as read.—*Carried.*

A resolution that had been presented at the Winter Convention by Mr. D. B. McColl, in reference to insurance for public liability and property damage, which had been referred to the Executive Committee, was read. It was moved by Mr. J. E. B. Phelps and seconded by Mr. R. L. Dobbin, THAT this resolution be referred to the Ontario Municipal Electrical Association.—*Carried.*

A letter from Border Chamber of Commerce and another from Hamilton Chamber of Commerce, soliciting our 1930 Convention, were read. These letters were referred to the Executive Committee of next year.

Mr. R. L. Dobbin, Chairman, Convention Committee, presented a report regarding preparations for the Summer Convention, details of which are as follows:

A special train will leave Toronto on the evening of July 2nd for Huntsville, the delegates arriving at Bigwin Inn before noon on July 3rd, arrangements being made for delegates to have breakfast either at Huntsville or on the boat after leaving Huntsville.

On July 3rd, luncheon will be served at 12 o'clock, when there will be no speaker. The first business session will start at 1.30 that afternoon, after which the remainder of the afternoon will be given over to sports. Dinner that night will be informal, there being no speaker. In the evening at 9 o'clock, there will be a dance.

On July 4th there will be a Convention session in the morning; noon luncheon with speaker, and the Convention dinner in the evening with speaker. The afternoon will be given over to sports and recreation.

On July 5th there will be a Convention session in the morning, luncheon at noon with speaker, and in the evening, dinner will be informal, when Convention prizes will be presented, after which the return boat trip to Huntsville will be made.

It was suggested that there be a registration fee for men of $1.00, and the Association was asked to contri bute $200.00 for Convention prizes.

After discussion on this report, Mr. Dobbin moved and Mr. R. H. Starr seconded, THAT the report be adopted, excepting that the $1.00 registration fee be omitted.—*Carried.*

Mr. O. H. Scott, Chairman, Papers Committee, presented suggestions for papers for the Convention, of which the following were decided as suitable:

Duties and Responsibilities of local Commissions.

A paper by Mr. Towne of the General Eelectric Co., on "Lightning Arresters."

Modern Billing Methods.

Paper on Refrigeration.

Rate situation in the Province.

Reports of Committees which will include report from the Pension and Insurance Committee.

It was moved by Mr. O. H. Scott and seconded by Mr. J. W. Peart, THAT the report of the Papers Committee be adopted.—*Carried.*

Mr. T. J. Hannigan consented to undertake obtaining speakers for the Convention luncheons and dinner.

The Convention Committee was asked to arrange to have loud speakers installed in the dining-room.

There being no further business the meeting adjourned.

Universal Safety

"Universal Safety" is being carried directly into millions of homes on this continent, through a series of thirteen consecutive weekly radio addresses, broadcast by outstanding leaders in the United States. The National Broadcasting Company, in co-operation with the National Safety Council, announced Charles M. Schwab as the first speaker of the 13 week program on Saturday evening, April 20, at 7.00 p.m., Eastern Standard time.

The following notables have already definitely agreed to talk :

CHARLES M. SCHWAB, Chairman of the Board, Bethlehem Steel Company; "Safety as a Factor in Industry."

HON. ROBERT P. LAMONT, Secretary of Commerce ; "Safety a National Problem."

HON JAMES J. DAVIS, Secretary of Labor; "Safety and the Worker."

MADAM SCHUMANN-HEINK, world-famous concert and operatic star ; "Safety in the Home."

DR. MILLER MCCLINTOCK, Director, Albert Russell Erskine Bureau of Street Traffic Research, Harvard University ; "Putting our Highways in Order."

Seven other widely known leaders have also been invited to take part in this vast Safety Symposium and the announcement of the entire list will be made in the immediate future.

The talks will be given from the New York station, WEAF, and a coast-to-coast hook-up will give ample opportunity for all of North America to hear and profit by the remarks of these celebrities. Practically all of the speakers have long been interested in the safety problem.

Other subjects to be discussed will be : "Death Through Accident"; "Safety in the Air"; "Safety on the Seas"; "Education—The Part it Plays in Safety"; "The Railroads and Safety"; and "The Automobile and Safety.' Thus the most vital points in the safety problem will be covered.

President Henry A. Reninger of the National Safety Council, introduced Mr. Schwab and outlined the series at the initial program which ran from 7.00 to 7.30 on Saturday evening, April 20. The other talks are being given on successive Saturday evenings at 7.30.

The campaign gives every promise of being the most significant and effective program of safety that has ever been carried out on this continent. The underlying purpose is to awaken the individual citizen as to his own personal responsibilities in accident prevention and to arouse the average mind from its lethargy and indifference toward one of the vital problems that confronts us to-day.

The National Broadcasting Company, realizing the seriousness of the national accident situation has generously thrown its entire broadcasting resources into the campaign and the message is being borne through the air, on the protective wings of "Universal Safety" directly into the homes of the people.

Hydro News Items

Central Ontario System

Rural contracts have been received sufficient to build a rural extension from Cataraqui to the Village of Sydenham.

* * * *

The Commission is now operating the Port Hope distribution system as a 4,160 volt, four-wire "Y" connected system, the change from a "Delta" connected system being made on Sunday, April 14th. This change was necessitated by the rapidly increasing load of the Port Hope Sanitary Co. which is located at a considerable distance from our transformer station.

* * * *

The Oshawa street railway uses direct current motors and up to the present, the direct current has been secured by the use of motor generator sets. Owing to the increasing business this Company has constructed a fine new building at the north end of the city. This building includes car-barns, repair shops and electrical substation. The four old motor generator sets have been replaced with one 1,200 kv-a., Mercury Arc Rectifier which requires no attendance, has a much higher efficiency, makes no noise and occupies about one-tenth the space required by the old generators.

* * * *

Extensive additions are now under way to the Belleville rural district and contracts have been received for an entirely new rural district out of the village of Norwood.

* * * *

Niagara System

A new 26,000 volt line from Essex high tension station has been put into operation. This is to supply a large power consumer in the district, as well as improve service to La Salle, Amherstburg and Sandwich.

* * * *

The Goderich Waterworks and Electric Light Commission has purchased an additional bank of station transformers which will increase the capacity by 1,500 kv-a.

* * * *

New offices are being opened in Listowel, Elmira and Stratford for the adjacent rural power districts. A resident lineman has been put in charge of Merlin rural power district, working under the Superintendent of Blenheim rural power district.

* * * *

St. Lawrence System

The Village of Cardinal has resumed negotiations for a supply of power. Estimates have been prepared on the cost of power and a distribution system.

* * * *

Estimates have been submitted to the Department of Public Works, for the delivery of 3,000 h.p. to the

Lower Lakes Terminal Elevator near Prescott.

* * * *

Rural contracts have been received, providing for the building of a line from Brockville to serve the villages of Lyn, Mallorytown, Lansdowne, and intervening district.

Courtesy

Every customer appreciates courtesy. He likes to spend his money where his business is welcomed and his patronage is valued. Nevertheless, the very best business organization frequently fails in extending simple courtesies.

You cannot afford to let any firm be more courteous than your own. Try to keep in mind that the real boss is the customer. It is his money that furnishes the sinews of war, that makes up the weekly payroll. He pays the rent and supply bills, and keeps the wheels running. When a customer comes to the office, exchange the courtesies of the day with him, try to see that he is given immediate attention and secures contact with the particular person with whom he wishes to do business.

In your everyday correspondence, put a smile into your voice. If the customer has expressed some fancied grievance in his letter, don't attempt to argue with him, do your level best to soothe him, tell him whatever the trouble is you will adjust it to his satisfaction. Dictation of this kind disarms a man, and the very spirit of courtesy makes it necessary for him to adopt the same attitude.

—*Pulp and Paper Magazine.*

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor.*

THE

BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Mr. C. A. Magrath's Letter of Submittal of the Twenty-first Annual Report

To His Honour
THE HONOURABLE WILLIAM D. ROSS,
Lieutenant-Governor of Ontario.

MAY IT PLEASE YOUR HONOUR:

The undersigned has the honour to present to your Honour the Twenty-first Annual Report of the Hydro-Electric Power Commission of Ontario for the fiscal year ending October 31, 1928.

This Report covers all of the Commission's activities and also embodies the financial statements of the municipal electric utilities operating in conjunction with the various systems of the Commission and supplying electrical service to the people of the Province.

Dealing, as it does, with a multiplicity of activities relating to several electrical systems obtaining power from twenty-two hydro-electrical plants operated by the Commission, supplemented by power purchased from other sources, and recording financial and other data relating to the individual local municipal electric utilities, the Annual Report presents a large amount of statistical information, much of which must, of necessity, be of a summary character.

The financial statements, the statistical data and the general information given, however, are so arranged and presented as to convey a comprehensive outlook on the features of the Commission's operations. Not only does the Report record the progress made during the past year, but it gives, in addition, certain cumulative results for the various periods during which operation has been maintained in the respective municipalities.

During the past year the work of the Commission has been characterized by consistent and steady growth. Throughout the winter of 1927-28 and during the ensuing spring and summer months, work on the initial unit of the transmission line bringing power from the Ottawa river watershed to supplement the supply for the Niagara system was rapidly pushed to completion, with the result

CONTENTS

Vol. XVI **No. 5**

May, 1929

	Page
Mr. C. A. Magrath's Letter of Submittal of the Twenty-first Annual Report - - - -	145
New Semi-outdoor Station in the Township of Scarboro - -	159
A Pioneer Electric Installation -	162
The Electrified Farm House -	164
Oscillograph Recording Apparatus for Toronto-Leaside Transformer Station - - - -	169
Hydro News Items - - -	178

that on October 1st, 1928, the line was formally placed in service. It consists of a single-circuit, 220,000-volt line designed to transmit 125,000 to 150,000 horsepower and extends from a point on the interprovincial boundary on the Ottawa River, where power is received from the Gatineau Power Company, to Leaside, on the outskirts of Toronto, a distance of 202 miles. The steel-reinforced aluminum cable used in this line aggregates 606 wire miles and is supported by nearly 1,000 steel towers. The completion of this line, much of it through rough and sparcely populated territory, within so short a period is regarded as a noteworthy engineering achievement.

The operation of all the systems has been carried on successfully and without serious trouble. The class of equipment provided in the Commission's generating plants and on its transmission networks, and the care with which it is maintained and operated have enabled the Commission to provide a remarkable continuity of service. This is indicated by the fact that power was never entirely off the Niagara system for a single minute during the year. On the Georgian Bay system the continued combined operation of the various generating plants has been very satisfactory and has resulted in an improved service. On the Georgian Bay system, the Central Ontario and Trent system, and the Nipissing system, special attention has been given to the problem of conserving and increasing the flow of streams.

Cost of Electrical Service Furnished by the Commission

The function of the Commission is not only to use its best endeavours to provide for the people of Ontario, at cost, an adequate and reliable supply of electrical energy, but also to ensure that the cost of that electrical energy to the consumers shall be the minimum consistent with the financial stability of the enterprise. The success that has been attained in the accomplishment of the latter object may be appreciated by a careful study of the statistical data relating to the supply of electrical energy to consumers as given in Statement "D" and the actual rates to consumers as presented in Statement "E," in conjunction with the various financial statements of the Report.

Growth of Load

The following tabulation (*Table No. 1*) shows the growth in load in the various systems during the year.

Financial Summaries

It will be observed that the financial statements embodied in this Report are presented in two main

TABLE NO. I.

DISTRIBUTION OF POWER TO SYSTEMS
20-MINUTE-PEAK HORSEPOWER

SYSTEM COINCIDENT PEAKS

System	October 1927	December 1927	October 1928	December 1928
Niagara system	810,322	853,960	879,357	894,772
Georgian Bay system	19,247	21,791	20,082	21,595
St. Lawrence system	8,246	9,033	9,896	9,759
Rideau system	3,290	3,123	3,351	3,466
Thunder Bay system	43,603	42,332	48,910	66,300
Ottawa system	18,480	18,794	20,241	21,213
Central Ontario and Trent system	43,458	47,994	47,493	50,389
Nipissing system	3,054	3,225	3,170	3,248
Total	949,700	1,000,252	1,032,500	1,070,742

divisions, namely, a division—Section IX—which deals with the operations of the Commission in the generation, transformation and transmission of electrical energy *to the co-operating municipalities*, and a division—Section X—which deals with the various operations of the municipal electric utilities in the localized distribution of electrical energy *to consumers.*

The cumulative results to date of the operation of the several systems of the Commission as set forth in this Report demonstrate a healthy financial condition.

The total investment of the Hydro-Electric Power Commission of Ontario in power undertakings and hydro-electric railways is $211,217,481.46, and the investment of the municipalities in distributing systems and other assets is $85,986,287.89, making in power and hydro-electric railway undertakings a total investment of $297,203,769.35. The total revenue derived from this capital investment aggregated $36,388,391.98 in the fiscal year 1928.

The following statement (*Table No. 2*) shows the capital invested in the respective systems and municipal undertakings:—

The following statement (*Table No. 3*) shows the combined revenue of the Hydro-Electric Power Commission and the municipal electric utilities :

REVENUE OF COMMISSION

As usual the Commission is able to report that the revenue obtained from the consumers has been more than sufficient to meet the full cost of generating and transmitting the electrical energy as well as to provide for all operating expenses and the fixed charges of the municipal utility equipments.

The Commission collected from the municipal utilities and other customers, for power sold, a total sum of $24,287,296.23. This sum was appropriated to meet all the necessary fixed charges and to provide for the expenses of operation and administration. After meeting all charges

TABLE NO. 2.

Niagara system	$161,994,023.61
Georgian Bay system	5,546,340.02
St. Lawrence system	1,852,165.93
Rideau system	1,189,021.46
Thunder Bay system	14,332,937.23
Ottawa system	201,331.53
Eastern Ontario transmission lines, etc.	895,236.64
Central Ontario and Trent system	14,157,630.78
Nipissing system	1,151,370.92
Hydro-electric railways	6,989,346.88
Office and service buildings, construction plant, inventories, etc	2,908,076.46
	$211,217,481.46
Municipalities' distributing systems and other assets (exclusive of $12,326,097.56 of municipal sinking fund equity in H.E.P.C. system)—all systems	85,986,287.89
	$297,203,769.35

TABLE NO. 3.

Revenue of the Hydro-Electric Power Commission :			
From the municipal electric utilities, rural power districts, Hydro-Electric railways and other power customers—			
Niagara system	$17,954,993.01		
Georgian Bay system	762,594.91		
St. Lawrence system	290,279.27		
Rideau system	154,600.76		
Thunder Bay system	1,145,031.55		
Ottawa system	205,099.84		
Bonnechere storage	4,210.53	$20,516,809.87	
From rural consumers—			
Niagara rural power districts	$1,166,221.80		
" rural lines	4,385.65		
Georgian Bay rural power districts	44,584.17		
" " rural lines	288.75		
St. Lawrence rural power districts	23,945.92		
Ottawa rural power district	21,669.23		
Central Ontario rural power districts	86,203.74	$1,347,299.26	
From the Central Ontario and Trent system, also Nipissing system and pulp mill		2,423,187.10	
		$24,287,296.23	
From Hydro-Electric Railways—			
Sandwich, Windsor & Amherstburg Rlwy	$1,158,710.72		
Guelph Radial Railway	115,310.19	1,274,020.91	
Total revenue of the Commission			$25,561,317.14
Revenue collected by the municipal electric utilities			26,376,465.09
Aggregate revenue of the Commission and the municipal electric utilities			$51,937,782.23

**Deduct :—*		
Revenue from power supplied to municipal electric utilities	$15,443,379.28	
Hydro-Electric Railways	106,010.97	
		15,549,390.25
Combined revenue		$36,388,391.98

* NOTE: This deduction is made due to the fact that the revenue of the municipal electric utilities is the source from which the Commission is reimbursed for the cost of power supplied to such utilities.

there was left a net surplus of $940,663.07.

The following statement (*Table No. 4*) summarizes the Commission's collections from municipal electric utilities and other power customers for the year and shows how the collections have been appropriated :

TABLE NO. 4.

Revenue from municipal electric utilities and other power customers		$24,287,296.23
Appropriated as follows :		
Operation, maintenance, administration, interest and other current expenses	$16,489,620.67	
Reserves for sinking fund, renewal of plant and equipment and contingencies	6,857,012.49	
		23,346,633.16
Net surplus, after providing for all expenses and necessary fixed charges, credited to municipalities and shown in their accounts		$940,663.07

Rural Electrification

During the past few years very substantial progress has been made in Ontario in the field of rural electrification. Practically all rural electrical service is now given through rural power districts which are operated directly by the Commission. There is now more than $7,200,000 invested in the rural power district systems established by the Commission. Towards this rural work the Ontario Government, pursuant to its policy of promoting the basic industry of agriculture, has, in the form of grants-in-aid, contributed 50 per cent. of the costs of transmission lines and equipment, or about $3,500,000. About 3,790 miles of transmission lines have been constructed to date, of which 929 miles were constructed during the past year, a mileage which exceeds that constructed in any former year. There are now more than 31,000 customers supplied in the rural power districts.

Municipal Electric Utilities

The following (*Table No. 6*) is a summary of the year's operation of the electric utilities of the municipalities which operate under cost contracts with the Commission :

TABLE NO. 5

RURAL POWER DISTRICTS—OPERATIONS FOR YEAR 1928

	Niagara system	Georgian Bay system	St. Lawrence system	Ottawa system	Central Ontario and Trent system and Nipissing system	Totals
	$ c.	$ c.	$ c.	$ c.	$ c.	$ c.
Cost of power as provided to be paid under Power Commission Act......	406,789.20	17,791.12	8,643.48	5,358.91	34,011.85	472,594.56
Cost of operation, maintenance and administration...	301,548.45	8,278.10	6,898.85	5,036.27	20,925.04	342,686.71
Interest...........	126,905.13	6,285.82	3,333.85	3,203.43	7,191.35	146,919.58
Renewals..........	107,703.56	4,656.41	2,605.91	2,687.03	6,013.54	123,666.45
Obsolescence and contingencies.....	161,555.34	4,656.38	2,605.92	1,343.51	3,091.24	173,252.39
Sinking fund........	28,553.37	1,418.82	697.50	710.38	....	31,380.07
Total expenses...	1,133,055.05	43,086.65	24,785.51	18,339.53	71,233.02	1,290.499.76
Revenue from customers..........	1,166,221.80	44,584.17	23,945.92	21,669.23	86,203.74	1,342,624.86
Surplus..........	33,166.75	1,497.52	....	3,329.70	14,970.72	52,964.69
Deficit..........	....	....	839.59	....	....	839.59
Net surplus....	....	....	....	....	....	52,125.10

TABLE NO. 6.

Total revenue collected by the municipal utilities...........		$26,376,465.09
Cost of power..........................	$14,688,570.08	
Operation, maintenance and administration..	4,608,430.46	
Debenture charges and interest.............	3,712,760.81	
Depreciation..........................	1,350,252.16	
Total..		$24,360,013.51
Surplus for the year, includes surplus from H.E.P.C.....		$2,016,451.58

The above covers only the municipalities operating under cost contracts with the Commission.

Reserves of Commission and Municipal Electric Utilities

The total reserves of the Commission and the municipal electric utilities for sinking fund, renewals, contingencies and insurance purposes amount to $76,280,929.60, made up as follows (*Table No. 7*) :

TABLE NO. 7.

Niagara system	$28,989,376.26
Georgian Bay system	1,417,747.44
St. Lawrence system	379,504.86
Rideau system	258,860.96
Thunder Bay system	954,005.63
Ottawa system	14,497.49
Central Ontario and Trent system	2,539,212.44
Nipissing system	182,415.74
Bonnechere system	13,774.82
Service buildings and equipment	499,137.91
Hydro-Electric Railways	140,803.90
Insurance—Workmen's Compensation and staff pension insurance	2,156,246.41
Total reserves of the Commission	$37,545,583.86
Total reserves of municipal electric utilities	38,735,345.74
Total Commission and municipal reserves	$76,280,929.60

The consolidated balance sheet of the municipal electric utilities, on page 251, shows a total cash balance of $1,342,367.07, and bonds and other investments of $1,837,140.51. The total surplus in the municipal books now amounts to $26,544,670.51, in addition to a depreciation reserve and sundry other reserves aggregating $12,258,053.31.

The following is a brief summary of the principal operations relating to the several systems of the Commission:

Niagara System

The Niagara system embraces all the territory lying between Niagara Falls, Hamilton, and Toronto on the east, and Windsor, Sarnia, and Goderich on the west, served with electrical energy generated at plants on the Niagara River.

There has been a steady increase in the number of consumers supplied in this district and also in the load supplied by the Commission to the municipalities. After a period of study of the operating characteristics of the canal and power plant with a view to obtaining the maximum efficiency and use of the development, it was decided to instal a tenth unit in the Queenston generating station.

Delivery of the first block of power from the Gatineau Power Company was made during October. This power is received by the Commission at the inter-provincial boundary on the Ottawa River and is transmitted over a 220,000-volt steel-tower transmission line to Leaside. The construction of a duplicate line in connection with this power supply will be undertaken during the coming year. In order to take care of the increasing demands in the western part of the Province, the Commission will construct during the coming year an additional 110,000-volt steel-tower line from Niagara Falls to St. Thomas.

The Commission in this system has a total capital investment of $161,994,023.61 and accumulated reserves for renewals, sinking fund and

contingencies aggregate $28,989,376-.26. In the rural power districts of this system, which are operated directly by the Commission, the revenue for the year from customers was $1,166,221.80, and the total cost of supplying the service was $1,133,-055.05, leaving a balance of $33,166.75 which is placed to the credit of the districts in this system. The greater part of this surplus is returnable to the users in the form of reduced rates.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power during the year was $732,022.84 less than the amounts of the interim bills. The municipal electric utilities operated with a net surplus of $1,467,-255.04 after providing $1,158,141.85 for depreciation and $1,450,453.85 for the retirement of installment and sinking fund debentures. Eighteeen municipalities had deficits during the year, aggregating $11,614.13. The total revenue of the municipal electric utilities in this system was $22,175,128.19, an increase of $1,384,021.54.

Georgian Bay System

The Georgian Bay system serves that portion of the Province adjacent to Georgian Bay, inclusive of the entire counties of Bruce, Grey, Simcoe, Dufferin and the district of Muskoka, as well as the northern portions of the counties of Huron, Wellington and Ontario, being the area north of the Niagara district and west of the Central Ontario District.

Electrical energy is obtained from five electrical developments and from a frequency changing station, through which a block of power is obtained from the Niagara system, all of which are tied together by a network of transmission lines. The combined capacity of these six sources of power approximates 22,000 horsepower. During the year, the construction of a sixth development was undertaken at Trethewey Falls on the south branch of the Muskoka River with a turbine capacity of 2,300 horsepower which will probably be completed and placed in operation during the summer of 1929. Surveys were made respecting a seventh developemnt for this district, on the Musquash River at Ragged rapids, and consideration is being given to the possibility of constructing a tie line to the Niagara system.

The results of the past year's operation were substantially better even than in 1927, which, up to that time, was the most successful year in the history of the system. A surplus was shown on the Commission's books from the sale of power to municipalities for every municipality on the system with the exception of one village, which showed a loss of about $200. The total capital invested by the Commission in this system is $5,546,340.02, and the accumulated reserves, inclusive of renewals, sinking fund, and contingencies aggregate $1,417,747.44. The revenue for the year from the rural power districts on this system which are directly operated by the Commission, amounted to $44,584.17, whereas the total cost of service was $43,086.65, thus leaving a balance of $1,497.52 to be placed to the credit of the system.

The results obtained during the year from the operation of the electrical utilities in the various

municipalities have been most satisfactory. The total cost of power during the year was $101,295.25 less than the total amount collected at the interim rates. The total net surplus for the year from the various municipal electrical utilities amounted to $134,144.50 after providing $48,301.40 for depreciation, and $51,066.26 for the retirement of instalment and sinking fund debentures. Five small municipalities operated with an aggregate loss of $1,847.41, whereas the total combined surplus of the other municipalities comprising this system was $135,991.91, and the total revenue collected was $1,024,863.76.

St. Lawrence System

The St. Lawrence system serves the district along the St. Lawrence River from Brockville east, as well as a number of towns north of the river.

Power for this system is purchased from the Cedars Rapids Transmission Company, delivery being made near Cornwall, and during the past year connection was made to the Gatineau power source by a transmission line from Brockville to Ottawa, thus securing for the system an abundant supply of power for future growth.

The Commission in this system has a total capital investment of $1,852,165.93 and accumulated reserves for renewals, sinking fund and contingencies aggregate $379,504.86. In the rural power districts of this system which are operated directly by the Commission, the revenue for the year from customers was $23,945.92, and the total cost of supplying the service was $24,785.51, leaving a debit balance of $839.59.

With respect to the electric utilities of the municipalities comprising this system, the actual cost of power during the year was $3,387.26 less than the amounts of the interim bills. The municipal electric utilities operated with a net surplus of $33,043.86 after providing $11,152.00 for depreciation and $9,064.79 for the retirement of instalment and sinking fund debentures. Two municipalities in this system had a small deficit of $516.84. The total revenue of the municipal electric utilities in this system was $215,318.88.

Rideau System

The Rideau system serves five urban municipalities. There has recently been organized a rural power district in the vicinity of Smiths Falls, which is expected to develop rapidly. This is the first rural power district in this system.

Power for this system is received from plants on the Mississippi River at High Falls and Carleton Place. Power is also purchased from the Rideau Power Company at Merrickville. The system will have reserve capacity from the Gatineau power line, through the 110,000-volt station erected in the vicinity of Smiths Falls. From this source, abundant supply of power will be available for the future growth of the system.

The Commission in this system has a total capital investment of $1,189,021.46 and accumulated reserves for renewals, sinking fund and contingencies aggregate $258,869.06.

With respect to the electric utilities of the municipalities comprising this system the actual cost of power during the year was $12,404.72 less

than the amounts of the interim bills. The various municipal electric utilities operated with a surplus of $20,550.73 after providing $9,510.00 for depreciation and $13,192.47 for the retirement of debenture debt. There were no deficits. The total revenue of the municipal electric utilities in this system was $224,795.54.

Thunder Bay System

The Thunder Bay system consists of the cities of Port Arthur and Fort William, and the Village of Nipigon, situated in the district of Thunder Bay at the head of the Great Lakes. Power for this system is obtained from a hydro-electric development at Cameron Falls on the Nipigon river about seventy miles east of Port Arthur.

The showing made by this system during the past year is most gratifying, as a surplus is shown in supplying power to the municipalities after providing liberally for contingency and renewal reserves, as well as interest and sinking fund charges.

Power in this district, apart from that utilized for ordinary domestic, commercial and municipal purposes, is largely employed by pulp and paper mills and terminal grain elevators in Port Arthur and Fort William. Although the pulp and paper industry passed through a period of depression last year on account of over-production, the greatest demand for power ever established in the district occurred during the month of November, 1928, and amounted to 65,000 horsepower. This exceeded the highest demand established during the previous year by approximately 18,000 horsepower. The City of Fort William, which passed through its second year of service from this system, made a much better showing than during the previous year, the average demand for power having increased by over 2,000 horsepower. The local electric utility in the municipality had a surplus for the year over and above all expenses, inclusive of depreciation of $10,000.

The highest peak established by the City of Port Arthur during the year was 42,147 horsepower, being 12,360 horsepower greater than the highest peak for the preceding year, and the average demand for the year exceeded that for the year 1927 by 4,750 horsepower.

The Commission has, in the Thunder Bay system, a total investment of $14,332,937.23, and accumulated reserves for renewals, contingencies, and sinking fund aggregating $954,005.63. The total revenue of the municipal electrical utilities in the system was $1,356,593.79, being $179,641.19 greater than in 1927, and the total revenue collected by the Commission for power sold to the municipalities and private companies was $1,145,031.55, or $114,636.45 greater than for total collections from customers during 1927. The three municipalities served by this system operated with a net surplus of $193,125.10 after providing depreciation to the extent of $35,398.00 and $22,882.10 for the retirement of debenture debt ; all three showing large surpluses.

As the Cameron Falls development is now completely loaded, eight years after it was first placed in operation, the Commission is making a careful investigation as to the necessity for

completing the Alexander development. This development will give an additional capacity of 54,000 horsepower.

Ottawa System

The Ottawa system comprises the City of Ottawa, the Village of Richmond, and the Nepean rural power district. For many years Ottawa has been receiving power through the Hydro-Electric Power Commission from the plant of the Ottawa and Hull Power Company. This Company is under contract to supply the Commission with 20,000 horsepower from its development in the City of Hull on the Quebec side of the Ottawa River opposite Ottawa. Both the Nepean rural power district and Richmond obtain their supply of power through the distribution system of the City of Ottawa, Richmond obtaining its power over the network of lines supplying the Nepean rural power district.

The power supply contracted for with the Ottawa and Hull Power Company is now all in use, and additional power is being obtained from the Gatineau Power Company by a special arrangement which employs the facilities of the generating plant of the Ottawa and Hull Power Company. Later, it is the intention to instal a 110,000-volt transformer station adjacent to the City.

Central Ontario and Trent System

The Central Ontario and Trent system comprises the municipalities east of Toronto as far as Kingston, connected, through a network of transmission lines, to generating plants situated on the Trent and Otonabee Rivers. An additional supply of power from the Gatineau Power Company has been made available through Smiths Falls by a transmission line connected at Kingston and an abundant supply of power has thus been obtained to meet the future growth of the system. Fifteen municipalities are under contract with the Commission for a supply of power, and own and operate their own distribution systems. Fourteen municipal electrical utilities are operated as Government properties.

For financial purposes, the Nipissing system referred to below, is included with the Central Ontario and Trent system. After operating, maintenance and interest charges were met out of the revenue from the system, the balance remaining was in excess of the sum required to meet in full the necessary amortization and depreciation reserves by $12,390.50. The total reserves to date, provided out of earnings and held specifically for the benefit of the system, amount to $2,721,628.18.

Nipissing System

This system serves the district adjacent to and inclusive of the city of North Bay, the town of Powassan, and the villages of Callander and Nipissing, adjacent to the eastern end of lake Nipissing. Two hydro-electric developments serve this system; both are situated on the South river, one at Nipissing and the other at Bingham Chute. During the year the Commission has undertaken a third development at Elliott Chute, a short distance above the Bingham Chute plant. The capacity of the

new development when completed will be 1,800 horsepower and it is expected that it will be placed in operation in the late summer of 1929. Due to a steady increase in demand for power at North Bay an additional circuit was constructed on the existing transmission line from the Bingham Chute development to the city limits and arrangements were made for providing a second substation inside the city limits.

The Annual Report

The Table of Contents, pages xxi and xxii, conveys a good understanding of the scope of the matters dealt with in the Report, to which there is also a comprehensive Index. To those not conversant with the Commission's Reports the following notes will be useful.

In Section II, pages 6 to 49, dealing with the Operation of the Systems, are a number of interesting diagrams showing, graphically, the increase in the loads on the various systems. Tables are also presented showing the amounts of power taken by the various municipalities during the past three years.

The rural distribution work of the Commission has proved of widespread interest and special reference to this is made in Section III, on pages 60 to 72. The power distributed to rural districts is, and possibly must always be, but a relatively small proportion of the power distributed by the Commission. The supplying of electrical service in rural areas, and especially on the farm, has, however, been of great economic benefit to Ontario. The Provincial Government grants-in-aid to this work have been of value to agricultural activities, and have assisted the Commission to extend transmission lines to many areas.

In Sections IV, V and VI will be found information respecting progress of work on new power developments and on transmission system extensions, together with photographic illustrations.

About three-fifths of the Report is devoted to statistical, financial data which are presented in two Sections, IX and X.

Section IX presents in summary form the financial statements relating to the operations of the Commission in the generation, transformation and transmission of electrical energy to the co-operating municipalities. It is introduced by an important explanatory statement which appears on pages 113 to 117, to which special reference should be made.

Section X presents in summary form the financial statements relating to the operations of the municipalities in the localized distribution of electrical energy to consumers. It also contains details of the costs of electrical energy to consumers in the various municipalities and tabular statements of the rates in force which have produced these costs. An explanation of the various tables and statements is given at the commencement of this Section on pages 245 to 247; and a special introduction to Statement "D," which relates to the cost of electrical service in Ontario, together with a diagram, appears on pages 354 to 357.

In its Annual Reports the Commission aims to present a comprehensive statement respecting the activities of the whole undertaking under

its administration. Explanatory statements descriptive of the operations of the Commission in various branches of its work are suitably placed throughout the Report in order that the citizens of the Province may be kept fully informed upon the working-out of the Commission's policies.

Water Rentals and Certain Advances from the Government

It is gratifying to be able to report that the Commission has reached a settlement with the Government of the Province on all outstanding questions in respect to water rentals to be paid by the Commission, including unpaid balances claimed from January 25, 1922, to date, and in respect to the repayment of certain moneys that had been advanced to the Commission and carried by the Province, during the period January 1, 1909, to October 31, 1925, and had been used for purposes incidental to the establishment and ultimate benefit of the power systems.

Both of these matters were finally settled and the Government is now completing all the leases to which the Commission is entitled. Further, a clear understanding has been reached as to the terms and conditions upon which additional leases required by the Commission for water privileges will be issued. It is a source of satisfaction to the Commission to be able to report that the undertaking is now absolutely free of all obligations to the Government of the Province, other than advances on account of capital upon which sinking fund payments and interest, as provided by law, are being promptly paid as they become due.

Reserves and Power Rates

As the accounts reveal, the Commission's reserves are increasing most satisfactorily. As late as 1925, these showed an increase over the previous year of about three and a half million dollars. In the year just closed the reserves would have shown an increase of fully eight million dollars were it not for the payments made to the Province in order to complete the settlements above referred to.

The absolute necessity for building up strong reserves in any Hydro-electric enterprise cannot too strongly be stressed, especially where power from sources of supply will have to be transmitted considerable distances. The Commission believes it has the unanimous support of the municipalities in such a policy, and especially so long as the favorable rates established by the Commission are maintained. The Commission realizes that there are a few places where, due to special local conditions, the rates are high compared with the vast majority of communities served by the Commission.

The endeavor of the Commission is not the concentration of industry at a few large power sites, but rather the broader policy of making as wide-spread a distribution of electrical energy as is economically possible. Such a policy stimulates industrial and commercial activity and results in a province-wide production of wealth, thereby adding to the general comfort and welfare of the people. In this connection the extension of rural lines—now about 1,000 miles yearly—plays an important part in the work of the organization. The Commission is aware that there are

some who feel more should be done by way of lower rates in certain rural communities. It must, however, be remembered that every enterprise, great or small, goes forward through a process of evolution—a year to year growth—and I am quite confident that inequalities which appear from time to time will be satisfactorily removed under the supervision of the Commission, and with the co-operation of the municipal systems, all of which have the single purpose of providing the consumer with the best possible service.

Acknowledgments

This report would be quite incomplete without an acknowledgment of the loyal support of all employees. This is no formal statement. Occasionally it is charged that this municipally-controlled organization suffers because of the lack of a directorate having a financial interest in the property. After three year's experience as Chairman, I confess that this feature does not concern me. The capacity and sincerity of purpose of the staff and others in every organization is, after all, what enables the best results to be obtained. It gives me much pleasure to pay this tribute to those carrying on the work of this hydro-electric enterprise throughout the vast areas of this Province. At the same time I must point out that such a fine sense of duty can only be maintained in the organization so long as those representing the people in the Legislature and elsewhere make it clear, at all times, that the services of the employees of this hydro-electric power enterprise are fully appreciated.

To the Press of the Province, the Commission again wishes to express its appreciation for the support and service given to this extensive public undertaking.

Respectfully submitted.

Charles A. Magrath,
Chairman.

New Semi-outdoor Station in the Township of Scarboro

A NEW 3,000 kv-a. distributing station located on Bonnington Avenue, just south of the Danforth Road in the Township of Scarboro has recently been completed by the Commission.

The station stands on a site with a frontage of 120 ft. on the east side of Bonnington Avenue and approximately 150 ft. deep and consists of an outdoor structure to accommodate the transformer and high voltage switching equipment and a brick building housing the low voltage switching equipment.

High Voltage Structure and Equipment

The outdoor structure is of fabricated steel construction throughout, approximately 29 ft. high and 34 ft. wide in two sections, the material for which was supplied by the Canadian Bridge Company of Walkerville, Ontario, and erected by the Commission's Construction Department.

One section is an entrance bay 14 ft. long for the incoming 13,200 volt line from the Leaside transformer station and the line oil breaker and disconnecting switches, etc., with provision for a second line.

The other section is a transformer bay 30 ft. long containing the bank of 3–1,000 kv-a., single phase transformers and the high voltage switching equipment in connection therewith; also the transformer low voltage bus, from which leads are run underground in lead covered cable to the transformer oil breaker inside the switch house. This bay is capable of accommodating two banks of transformers, one on either side of the runway through the centre of the structure. The whole structure is symmetrical on the transformer runway, the equipment on one side being a duplicate of that on the other. The site is large enough to accommodate three transformer bays or a total of six banks of 1,000 kv-a. single phase transformers, making an ultimate station capacity of 18,000 kv-a. A spare transformer is installed next the present bank which may be quickly connected in circuit to replace any transformer in the bank which fails for any reason.

As will be seen from the accompanying diagram, the incoming 13,200 volt line with "LV" type lightning arresters for protection is connected through choke coils, disconnecting switches and Westinghouse type "CH-1" oil breakers to a line bus. A station bus running the length of the structure is connected to the line bus and from it, are tapped off the transformer banks through air-break switches. Westinghouse type "MB" current transformers are inserted in the high voltage leads to the transformer banks for the ammeters measuring the current in each bank and also for the relays which operate the line oil breaker in case of overload on the transformers.

The four transformers comprising the present bank and the spare unit were supplied by the English Electric

Company. The line breaker, high voltage arresters and current transformers were supplied by the Canadian Westinghouse Company and the remainder of the equipment by the Commission.

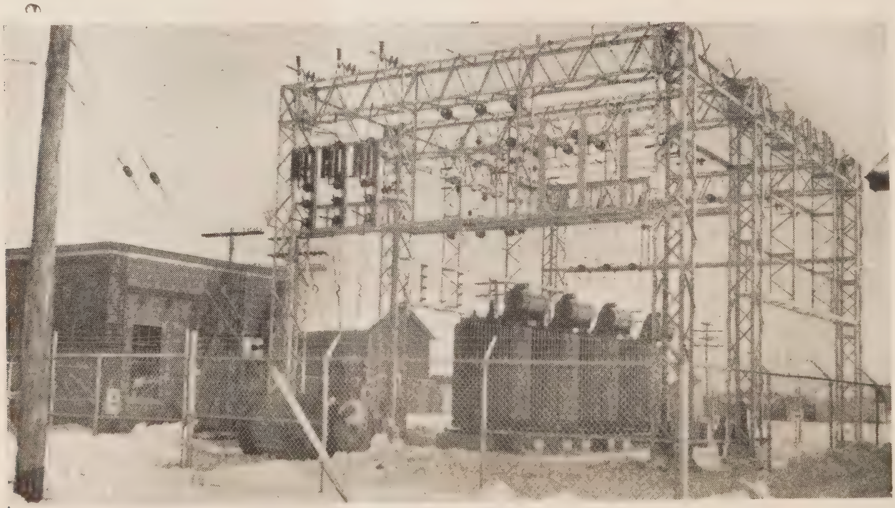
Low Voltage Building and Equipment

The low voltage switching equipment is housed in a one-storey brick building 20 ft. wide by 37½ ft. long and approximately 15 ft. high inside. The exterior of this building is of Cooksville corduroy brown range brick and the inside is finished with Cooksville buff pressed brick.

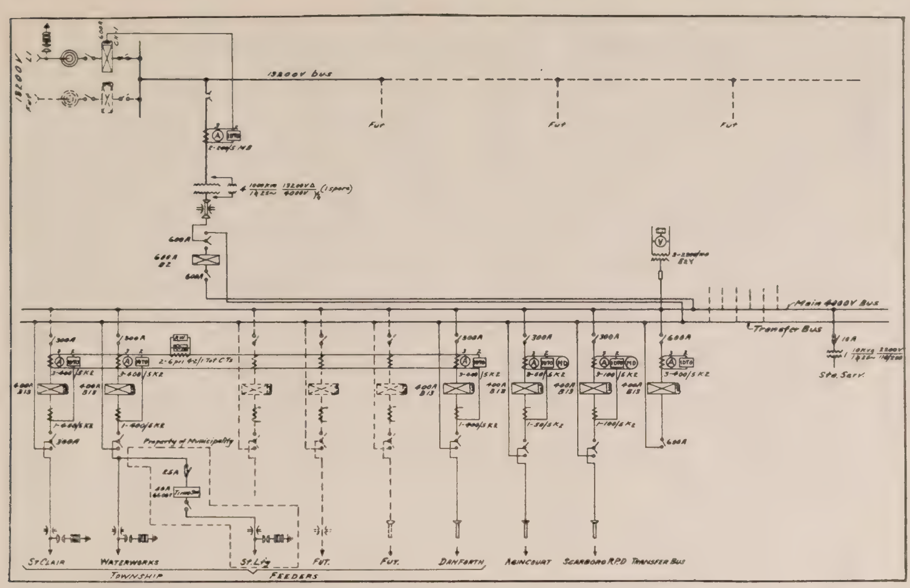
The present building accommodates 4,000 volt switching equipment for one transformer bank, five feeders and a transfer bus feeder. There is space in the building for the necessary switching for three more transformer feeders and three more out-going feeders. If more than four transformer banks should be required, the building could be extended another 15 ft. which would take care of two more banks and four more feeders.

At present three feeders are taken out underground on the west side of the building supplying power at 4,000 volts to the Danforth district, Scarboro Rural Power District and Agincourt, and two feeders run out overhead on the east side supplying power to St. Clair Avenue district and the Scarboro Waterworks. A street-lighting feeder, the property of the Municipality, is tapped off the Waterworks feeder inside the station and controlled by an Anderson time switch and supplies the lighting for the township.

The switch structure is built of 1¼ in. steel pipe and supports the switchboard and all the switching equipment. There is a main bus of two—2 in. by ¼ in. copper bars on edge and a transfer bus of one—2 in. by ¼ in. copper bar on edge. All the feeders are controlled by Westinghouse type "B-13" oil breakers, hand-operated, remote control with 24



Scarboro Township Distributing Station



Scarboro Township Distributing Station Wiring Diagram

volt d.c., trip, the current for which is supplied by a battery of 12 Exide type "KXF" cells which are kept up to proper voltage by a Union Switch and Signal Company's rectifier charger.

With the above transfer bus arrangement it is possible to take out any oil breaker for inspection at any time without taking a feeder out of service. This was considered advisable on account of the importance of the loads fed from this station.

The major part of the 4,000 volt equipment with the exception of the disconnecting switches and meters was supplied by the Canadian Westinghouse Company. The disconnecting switches were supplied by the Commission and the ammeters and voltmeter are the Weston small model type.

Metering

The load on the three township feeders is measured by means of a Canadian Westinghouse Company recording wattmeter and reactive volt-ampere meter connected to the secondaries of a multi-primary current transformer. The Agincourt and rural loads are each metered by a Lincoln indicating demand meter.

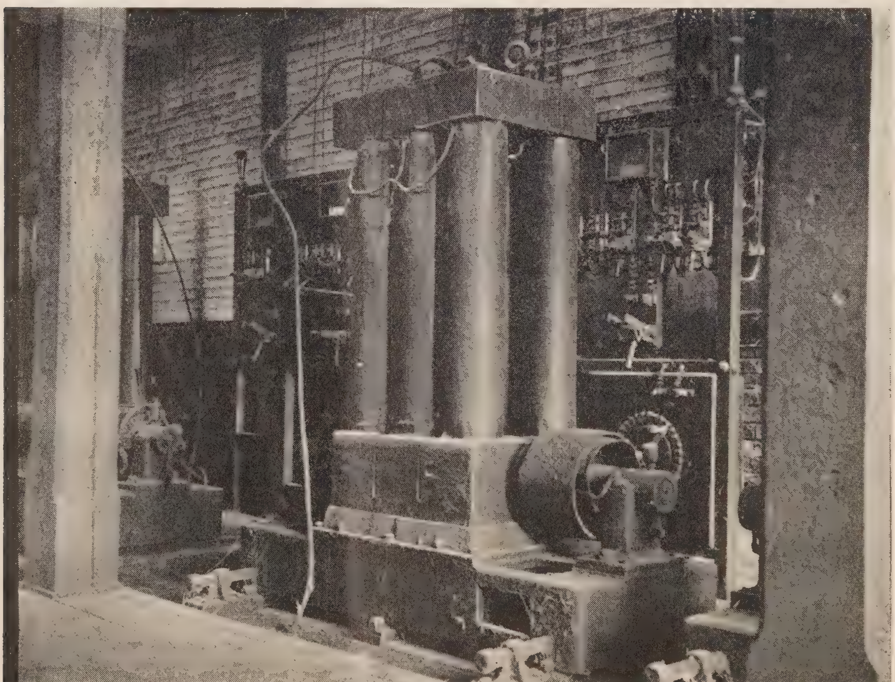
A Pioneer Electric Installation

THE illustration with this article is of an Edison bipolar d.c. generator that operated for a number of years in the plant of the Canada Cotton Company, now known as the Canadian Cottons Limited of Cornwall, Ont. It was installed in the early part of 1883 and started operation on February 28th of that year, remaining in service until 1913. It had a capacity of 16 horsepower and weighed 4,875 pounds. Mr. Thomas A. Edison personally supervised the installation and was present when it was placed in service.

The original installation was added to from time to time until there were six such machines in a line, four of the type shown and two of a later design, having but one winding per pole. They were all driven from a shaft under the floor, the belts coming up through the holes left in the bed plates for that purpose. The switchboard was made of wood to which were attached slate bases mounting the field rheostats, the quick break switches with link fuses and the ammeters.

An editorial appeared in a Cornwall paper two days after the plant was started, as follows:

"The new weave shed of the Canada Cotton Co. was on Wednesday evening (February 28th) lighted



Edison Generator Installed in 1883 at Cornwall, Ont.

for the first time by the Edison Electric Light. It revealed, so we are informed, the objection which has in many instances been fatal to its success, and that is a too intense and flickering brilliancy. It has been established that the electric light when used in manufacturing establishments has produced all the most dangerous and afflicting forms of ophthalmia among the operatives. It may be that the light in the weave shed here possesses some exceptional charm—some soothing influence—for instance, a liberal commission. However, if it ultimately proves a success we shall be pleased to chronicle the fact but in the meantime we agree with a leading English authority that electric light has had its day, and the fact that gas stocks are in no way affected by that light indicated that it is not regarded as a formidable rival."

In the light of the progress that has been made since that time in the science of power generation and distribution one cannot help being amused at the lack of imagination shown by the writer of the editorial.

The True Humanizer

Not long ago I heard a certain British literary man of magnificent craftsmanship and fine influence in his own field declare that he saw no values in our modern "mechanical age." Further, this same man recently visited a plant where the very foundations of our modern civilization are being laid. A ton of earth lies underneath a mountain. Scattered through that ton in infinitesimal grains is just two dollars' worth of copper. That ton of earth is being dug out of its resting place, transported to the mill miles away, the infinitesimal particles of copper miraculously picked out by invisible chemical forces, then deposited in great sheets by the equally invisible forces of the electric current, then shipped three thousand miles and again refined, then drawn into wires to transport the formerly wasted energy of a waterfall—and all these operations from the buried ton of Arizona dirt to refined copper in New York, done at a cost of less than two dollars, for there was no more value there.

This amazing achievement not only did not interest this humanist, but he complained about disfiguring the desert by electrical transmission lines. Unbelievable blindness—a soul without a spark of imagination, else it would have seen the hundred thousand powerful, prancing horses which are speeding along each of those wires, transforming the desert into a garden making it possible for him and his kind to live and work without standing on the bowed backs of human slaves as his protype has always done in ages past. Seen in this role, that humanist was neither humanist nor philosopher, for he was not really interested in humanity. In this picture it is the scientist who is the real humanist.—*Robert A. Millikan*, in the *Atlantic Monthly*.

The Electrified Farm House

By Edith M. Chapman

THE following by Edith M. Chapman, Editor Women's and Home Section of the *Ontario Farmer*, was prepared after she had visited a number of homes on Ontario farms. The story gives impressions obtained from Hydro users independently and we are therefore pleased to reproduce it.

The greatest forward movement for home welfare in the last twenty years has been made not because of women's advanced knowledge of household science, nor through the belated development of mechanical home equipment, but through *the new attitude of men to their homes*. It is only within the last quarter century that even a city man would be seen pushing a baby carriage or washing the supper dishes. Farmers were so busy clearing their land and building their barns, that little interest in housework was expected of them. And then somehow, somewhere, a nasty little libel on farmers was started. People said that they put all their improvements in their barns and none in their houses. There was an old story that never failed to make a hit at Farmer's Institute meetings, about a man who built a fine barn with running water for every cow in the stable, while his wife still struggled along in the house that had been built for his grandmother, and carried water from a spring at the foot of a hill. And when he came home from town one day, he found that his wife had called in the neighbours to help her, and had moved every stick of furniture from the house to the barn. She had decided that she would prefer to live there where things were convenient.

We almost believed this story ourselves, once, but we have learned a lot since—mostly within the last year. For if home conveniences have been the slowest of modern improvements to come to the farm, they are coming now with the speed characteristic of everything else that has to do with the "woman's movement." Last fall we attended a farm women's meeting in a district in Peel county where Hydro had just been installed. The women were buzzing like so many bees, about the merits of their new electric washing-machines. We found that most of the machines had been bought before the wiring of the house was completed. A junior institute bride, returning from her wedding trip, found her new electric washer waiting for her at the station, with another just like it for her mother. It was the first power washer her mother had ever had. So the world moves.

A few days ago, on a visit to a number of farms in the Woodbridge district, we saw for ourselves what electricity means to the women and to the comfort of the whole farm family. At the home of Henry Ellis near Nobleton, hydro-power lights the house, runs the washing machine, the electric iron and toaster, and pumps water to a sink in the pantry and a bathroom upstairs. In the way of farm work, it lights the barn and all

the outbuildings, getting the hens up in good time on dark winter mornings, pumps water for the stock and runs the cream separator and the chopper. What it saves in chopping the grain, alone, Mr. Ellis believes pays for the entire running cost, and the other farmers we visited, who do their chopping at home agreed with this. On the Ellis farm this running cost last year amounted to $58,57 for the whole year, or $4.88 a month, an average of $14.64 per quarter; all hydro bills are paid quarterly.

Asked about the initial cost, or the cost of installation, Mr. Ellis said : "Ours would hardly be a fair estimate because we had a private plant before we put in hydro, and the wiring for that cost $110 for the house and $70 for the barn. I know it cost me $60 to change the wiring from the private plant to the hydro, besides the cost of the motor."

"And how do you feel about the 'twenty-year mortgage'?" we asked.

"I don't worry about that at all." he said. "I'd worry a lot more if there was no such arrangement, and if some dropped out the rest of us would have to pay for the power they should be using as well as our own."

"We made one mistake," he remarked — and this is where the modern farmer's concern for his home was so evident—"We didn't have the house wired for a stove, and we'll have to have one before long,"—and when his wife protested at the possible cost— "wood's getting very scarce around here". One neighbour has lots of it and still he uses an electric stove; says it wouldn't pay to take down good trees, and bring in a saw to cut them. Anyway, if a man had to do the cooking and the ironing in hot weather he'd have an electric stove and an iron if he could get them, no matter what it cost to run them."

When we asked Mrs. Ellis what they found most helpful in their equipment, she replied : "I'd hate to have to decide that. I think I like the washing machine and the iron best. The laundry work is quite a business in itself on a farm, you know. I might have valued the bathroom most, but we had a bathroom with a hand pump before we had electricity, so it wasn't such a novelty. Of course we don't feel that we have to save the water the same now that no person has to pump it. Then, we would hate to give up the lights. Farmers have to do a lot of work before and after daylight during the short days, especially if they sell milk and have to get it to the station for an early train, and it means a lot to have a good light at the stove and the sink and wherever you have to work, besides the safety of it, at both the house and the barn. It used to take me twenty minutes at the quickest to clean and fill all the lamps and the lanterns every morning—that makes at least two hours a week saved."

The kitchen in the Ellis home is arranged after the increasingly popular idea of having a "kitchen-dining-room," where the table can be set not far from the cook-stove, and where a pleasant dining-room atmosphere can be maintained by taking the "cluttery work" from the kitchen to a washroom. The "kitchen sink" is set in the washroom close to the cupboards and right in front of a window looking toward the

orchard—farm women are coming to appreciate more fully the value of a cheerful outlook from their work-rooms. And the kitchen with its light, gaily colored walls and floor linoleum, a rocker at one window and a couch at another, and a dining table with a white cloth not five steps from range, would convert anyone to the custom of eating in the kitchen.

When we spoke of the almost incredible change in farm conditions in the last twenty years, Mrs. Ellis said : "Farmers nowadays like to have things nice, the same as city people do. Another reason for the labor-savers is that we can't get help either for the house or the farm as we used to do. Some of the conveniences that may look like luxuries are necessities. And who needs them more than the farm woman ? She not only takes care of her house as the city woman does, but she's always helping the man out in some way. Most women on dairy farms help with the milking part of the year at least. And most of us have our poultry flocks." We found that the turnover from her flock—or perhaps it is her daughter who has charge of the poultry, was over six hundred dollars last year. It would seem that it might be profitable, as well as more interesting, for a woman to let mechanical power do the purely mechanical things in housework, and to use her own hands and her time in such income producing work as raising chickens.

It was Monday morning, and we found Mrs. Louis Agar, of Kleinburg, in the midst of her weekly washing, neat as a pin, unruffled as a hostess at afternoon tea. The electric machine was, of course, doing the actual work. The washing for a family of four would be done in about an hour, she explained—not that the time mattered so much, since a woman was free to do other chores in the intervals between shifts of clothes ; and women didn't get up at five o'clock on wash days any more just to get their clothes on the line before their neighbours. The main thing was that one wasn't tired out when the washing was done. What a saving of frayed nerves and little domestic jars must follow the substitution of electric power for woman power !

The Agars keep about thirty cows and their "hydro" runs the milking machine, lights the house and barn, and runs the washing machine and electric iron. They have a bathroom but they are still using a hand pump with their pressure tank. "We're thinking of getting an electric range this summer," Mrs. Agar told us. "Mr. Agar doesn't like to cut down trees for wood." We might have guessed that from the beautiful array of ornamental trees growing about the house. The running cost of this plant was $72.88 last year, an average of $6 a month or $18 a quarter. Of the initial cost, Mrs. Agar said, "We're forgotten all about that. When we first turned on the light we felt that we had been living in the dark for years."

At Nashville, we called on Mrs. James Bernath. On this farm, electricity lights the house and barn, pumps the water, milks the cows, chops the grain, does the washing, keeps the water on tap in the kitchen and bath-room, and heats the electric iron and range, all at a cost of $11.35

a month. When asked what she found of most help, Mrs. Bernath said she couldn't get along without any of them, they were "all so much better than the old way." Then she gave us this enlightening view.

"I had to work hard in my younger days ; we had quite a family and there was always a lot to do, so I appreciate these conveniences. I tell my girls that if I had always had them I would be a younger woman to-day. And I like to think that other women are getting them now while their children are little and they need the help most. You asked just now if we felt the initial cost a burden. We didn't, because we prepared for it, and when you prepare for it in advance, no expenditure seems a burden. But sometimes I think it's a fine thing that young people nowadays go ahead and get the things that they really need to help them and pay for them as they go. If one's health is broken down there isn't much hope of getting ahead. Of course our men think that the hydro pays well for itself. Taking everything into account, the milking and the chopping with the rest, we are not at more expense than we were before."

In spite of Mrs. Bernath's confession of the burden of the years, she is still young in appearance and in spirit, a charming woman with her grown-up family in her fine big house, equipped to live in as every farm house should be. She remarked that she must get an electric vacuum cleaner, that she would have had one before, but she had a carpet on only one room in the house, a big parlor or living-room well over twenty feet long. The rest of the floors are covered with linoleum or left bare and varnished, so that only a chemical mop is necessary to care for them. And she has a very practical kitchen arrangement. When the electric range was put in the main kitchen, the coal and wood range was moved out to a summer kitchen with the electric washer, and here they have a most convenient laundry room entirely out of the way of the inner rooms of the house.

Some of the more unusual equipment in R. J. Watson's home near Bolton, included a combination coal or wood and electric range, an electric water heater in the bath-room, and electric curling tongs, in addition to the electric washer, iron, vacuum cleaner and toaster. Electric refrigeration, Mrs. Watson says, is to be the next improvement. At the barn, electricity runs the cream separator, the chopper and the straw cutter. The cost for power last year was $77.56, an average of $19.39 per quarter, or $6.46 each month.

The housewife's first affections here seem to be about evenly divided between the hot water heater and the combination range. "In the summer time whenever we wanted a hot bath, we used to have to carry kettles of hot water up to the bathroom," she said. "Now, by pushing a button, we can have a hot bath ready in a few minutes. With the combination range there is no unnecessary heat in the house in warm weather, but we still have a coal fire to heat the kitchen in the winter time."

This is a very modern house, but, as in the case of most farm houses,

the builder counted on the cook-stove heating the kitchen. Even with furnace heating becoming as general as it is on Ontario farms, it will be some time before a coal or wood fire can be dispensed with in farm kitchens in cold weather, whether the coal range is set up beside the electric, or built in combination with it.

Mrs. Watson has done some rather clever remodelling of her kitchen. It was, originally, a very large room, considerably longer than it was wide. A walk ran from the lane straight to its door, with the result that everyone coming to the house entered through the kitchen—a custom which will get on the nerves of the best natured housekeeper sometimes. Mrs. Watson couldn't move the lane and she couldn't move the kitchen, so, at the end of the room where the sink and the stove were set, she had a space about nine feet wide by twelve feet long, partitioned off with a wall reaching not quite to the ceiling. This she calls her kitchenette The rest of the room then becomes a separate dining-room, but it is only a step from the stove and general working centre.

Another thing that we noticed in this house was the beauty which comes automatically to an electrically lighted home in the way of shaded lamps. Many of these may be hand-made at home; their effectiveness every woman knows.

Some other appliances which may be in general use on electrified farms but which seemed rather unique to us, are at work on Elmer Rothwell's place at Lefroy. We could not visit this farm but we talked to Miss Rothwell and found that in addition to having electricity pump the water for the house and barn and run the chopper, the fanning-mill, the cream separator, the washing machine and electric iron, they are having most satisfactory service from a battery charger, to recharge the batteries of the car and the radio, a furnace blower which enables them to burn the cheaper fine coal, and maintains an even temperature in the house day and night, and a hydrant on the lawn, making it the work of a few minutes to water the garden with a hose where they used to have to carry water by pailfuls or let the plants go thirsty in hot weather. We suppose this hydrant can also be used for fire protection. . . . Certainly we're living in fast changing times in the country.

Oscillograph Recording Apparatus for Toronto-Leaside Transformer Station.

By G. D. Floyd, Testing Engineer, Electrical and Testing Dept., H.E.P.C. of Ont.

AN addition to the ordinary metering equipment found in High Voltage Sub-stations of large capacity is now being installed in Toronto-Leaside Transformer Station. This is a multi-element oscillograph, capable of recording magnitude and wave form of 9 electrical quantities, either voltages, current or power.

The installation of this apparatus at the above station was proposed in order that data might be obtained covering the variation and duration of disturbances such as occur in a station when flashovers on lines, or other abnormal conditions arise. The importance of the Toronto-Leaside station as a tie-station between two large systems whose generating stations are separated by relatively long distances, requires that all information regarding the operation of the systems during and immediately following abnormal conditions should be ascertained. As these abnormal conditions are usually of short duration and cannot be accurately recorded on the ordinary graphic instruments to be found in sub-stations, the oscillograph is the only instrument available.

The multi-element instrument which is now being installed at Leaside has been designed so that it may be easily installed as a semi-permanent piece of equipment in a station to record the abnormal voltages, currents and power swings which occur immediately following a fault on the systems connected to the station. When installed in this way, it is fully automatic and will start making a record immediately following a chance disturbance, if this disturbance is of such a nature as to operate the relay which starts the instrument.

This instrument has also been designed so that it may be used as a portable piece of equipment to measure and record any quantities desired on what is known as a staged test. When used in this way, it is not usually started automatically but rather itself starts the phenomena which it is desired to record. This may be the closing or opening of a circuit breaker, the operation of a relay, the starting of a motor or generator, or any condition associated with the quantities which are to be recorded.

The instrument itself and a number of its accessories are shown in *Fig. 1*. The main unit is contained in a box 25 in. long, 11 in. broad, 9½ in. high. This box contains the complete optical system including the lamp for furnishing illumination to the vibrator mirrors, the six vertical elements and three horizontal elements, series resistors for each element, control for the lamp and driving motor and control for the operation of the shutter which is used when recording.

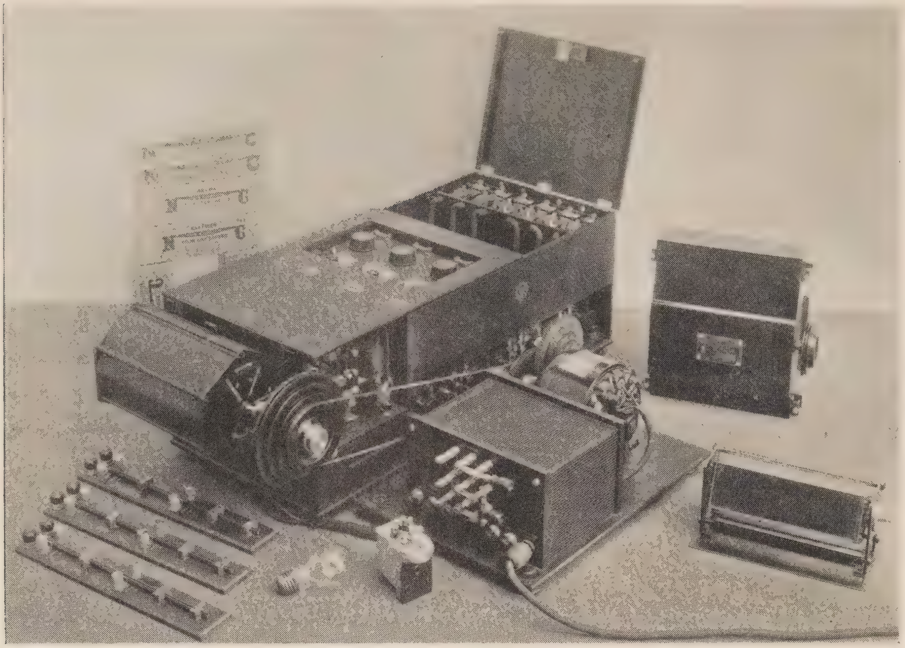


Fig. 1. Multi-element Oscillograph and accessories

Two film holders are provided, these are both daylight loading and are known as the rotating drum film holder and the long film holder. The first is shown attached to the front of the oscillograph in *Fig. 1.* The second is shown at the right-hand rear. The rotating drum film holder is used when short exposures are desired, the record on this film being limited to 10½ in. in length. The long film holder is used when a record of several seconds duration is desired, and is designed to take film up to 24 ft. in length.

A wide variation in speed of recording is provided by suitable control on the driving motors, and by step pulleys on the driving head.

Two motors are provided, an a.c. motor which is shown in the figure, and a d.c. motor, not shown. The a.c. motor is driven from an ordinary service outlet and there is also a transformer which steps the voltage down to approximately 6 volts which is applied to the incadescent lamp in the main unit. The driving motor is back geared and has step pulleys so that a wide variety of speeds may be obtained. The d.c. motor has field control and is operated from a 6 volt lead cell battery, which is also used to operate the lamp when the d.c. motor is used. The use of a 6 volt battery makes the instrument very portable in that it can be used in stations where no direct current is available, and on tests where the a.c. service in the station may be interrupted.

In many investigations, it is not necessary to record the quantities being investigated, and where visual

examination only is desired, a polygon of mirrors driven by the driving head of the instrument is used. The polygon of mirrors for this instrument is shown at the right of *Fig. 1*. It is attached to the front of the instrument in place of the film holder and rotated at suitable speed; the vibrations of the beams of light from the galvanometers being projected on the mirrors, are shown as the wave form of the quantities being studied.

The standard vibrator has a natural period of between 5,000 and 6,000 cycles per second, and requires approximately 0.12 amperes for 1 inch deflection. This sensitivity requires that if a voltage is to be measured, relatively high resistance must be placed in series with the elements if the voltage is of any magnitude. Similarly, if a current record is desired, it is imperative that a shunt be used to carry the main current, and the drop across this shunt measured on the element, if the current is of any magnitude.

Two types of wattmeters are available, the first a single-phase wattmeter which measures and records the instantaneous watts corresponding to the current and voltage impressed across it. The wattmeter is uniform in size with the current and voltage elements and can be accommodated in the space required for one of the latter, but it has an electromagnetic field instead of a field produced by a permanent magnet, which is the source of field for the current and voltage elements.

A polyphase instantaneous wattmeter unit is also available, uniform in size with the current and voltage elements which will measure the polyphase instantaneous watts of any circuit to which it is connected.

The wattmeter elements incorporated in this oscillograph are extremely useful, and are a new departure in oscillograph recording apparatus.

This brief description cannot go into detail into any of the parts of the oscillograph, and is intended only as an outline of its main features. A detailed description of the instrument and its operation is given in the *Electric Journal* for October, 1927.

The following outline of a typical staged test will illustrate how the oscillograph is used to record various quantities. Assume, that it is desired to record the building up of fault current and the operation of a relay when a circuit breaker is closed in on a fault. The voltage on the system may be recorded on a voltage element, the fault current on a current element through a current transformer connected in the phase in which the fault occurs, the time of closing of the relay by looping a current element in series with the contact of the relay. If the total time during which the fault is on the system is known roughly and is relatively short the speed of recording may be set so that the whole record may be taken on a short film. The shutter operating mechanism on the oscillograph has a switch associated with it which can be closed at any pre-determined time before the shutter opens. This switch may be associated with the circuit closing control of the circuit breaker, and set so that the shutter will open after a certain time has elapsed. In this way, the time lag of the closing of the circuit breaker is allowed for. All

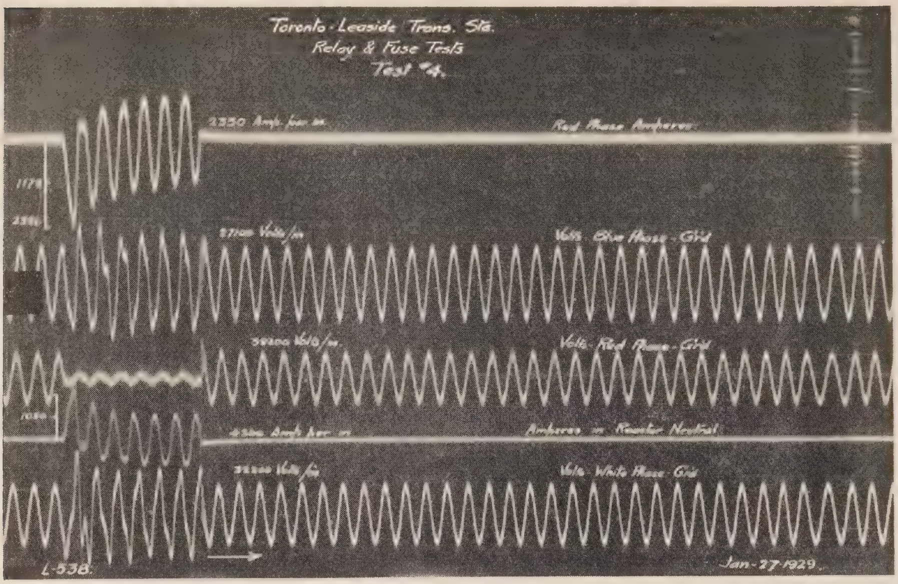


Fig. 2.

these connections and adjustments having been made, it is only necessary to close a switch on the oscillograph and all operations after that take place automatically as follows,— The switch associated with the shutter mechanism initiates the closing of the circuit breaker. Just previous to the time when the contacts of the circuit breaker make, the shutter on the oscillograph is opened and the normal quantities which are being recorded are allowed to start a record on the film. As the circuit breaker closes establishing the fault, the abnormal quantities are recorded, and if the fault has been removed by the relay before the completion of one revolution of the film, the relay operation and the interruption of the

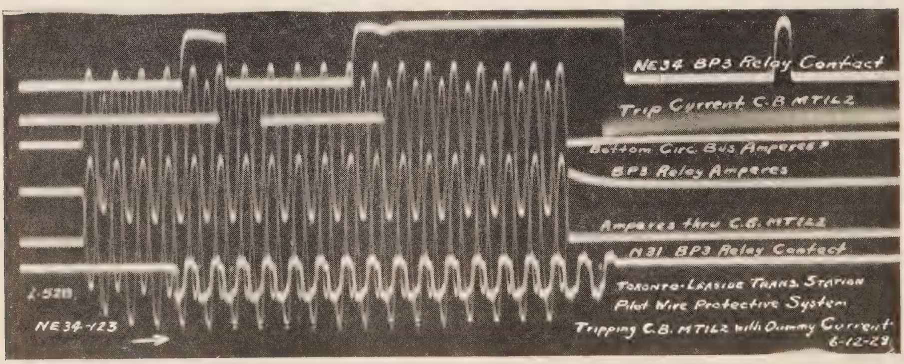


Fig. 3.

current are also shown. After one revolution has been completed, the shutter operating mechanism closes the shutter and extinguishes the lamp. It is essential that the lamp circuit be interrupted as the lamp is operated above its normal voltage while the exposure is being made.

Fig. 2, shows a typical record obtained in the manner just described. The first few cycles of the normal condition before the establishment of the fault are shown at the extreme left of the film. The fault continued for 6 cycles and was then interrupted, and the record showed the re-establishment of normal voltage on the various phases recorded.

Fig. 3 shows a record taken on a test of a sensitive pilot wire protective system. This record shows the instant the fault was established, the amount of fault current flowing, the amount of current flowing through the pilot wire relay, the instant the pilot wire relay contacts closed and the instant that trip current was applied to the circuit breaker which cleared the fault. The time for clearance of the fault was also shown. The bottom record is most interesting. This shows the time when the pilot wire primary relay contacts closed at a station three miles away from the location of the oscillograph. Six quantities are recorded on this oscillogram which is only 3½ inches in width. Each quantity can be easily distinguished and the value of the quantity scaled off with reasonable accuracy. The time during which the short circuit was on was approximately three-quarters of a second so that it will be appreciated that no indicating instrument could be depended upon to measure a quantity which existed for so short a time. Furthermore, the current through the primary relay was approximately 62 milliamperes, which would require a very sensitive indicating meter to read. It is, however, easily recorded on the oscillograph, and has its wave form as well as magnitude recorded permanently.

This instrument has proved very useful indeed on a number of staged tests in a field in which the ordinary indicating instrument would have been unsatisfactory. When it is installed for automatic operation in Leaside Station, it is expected that the records obtained from it will be equally as useful. The record of fault current, power swings, and voltage changes during and after the occurrence of a fault on the system taken with the relay operations occurring should give a fairly authentic story as to the duration and location of the fault, and furnish other information which is extremely valuable in studying the cause of the disturbance and its effect on operation.

Recent Visitors

On May 7th and 8th we had two distinguished visitors in Sir Andrew Duncan, Chairman of the Central Electricity Board of Britain, and Mr. Archibald Page, Chief Engineer and Manager. Sir Andrew Duncan and Mr. Page are making an extensive visit to Canada and the United States for the purpose of obtaining first-hand information regarding the methods used on this continent in distributing electric power to the consumers. Our visitors were much interested in the activities of the Commission, and in the remarkable results shown by the low rates. The transmission system used by the Commission, and especially the 220 kv. station at Leaside received their interested attention, as did also a visit to several farms close to the City of Toronto where electric service is being used to advantage.

On May 8th arrangements were made to take the visitors to Niagara Falls and included in the party were Sir Andrew and Lady Duncan, Mr. and Mrs. Page, and Mr. Fred Morrow of Toronto. Mr. Jackson, Manager of the Queen Victoria Niagara Falls Park Commission, acting on instructions from Premier Ferguson, arranged for luncheon and also for a sight-seeing trip for the ladies. Sir Andrew, Mr. Page and Mr. Morrow visited the three generating plants of the Commission, and the entire party appeared to enjoy the day very much indeed.

The Central Electricity Board of Britain has up to the present time confined its activities largely to the generation of electric power at large steam stations advantageously situated, the distribution of power to municipally owned plants and also to private companies having franchises for the distribution of electricity in a number of municipalities throughout Great Britain. The project is financed entirely by the Government, and the object is to eliminate as much as possible the very large number of small inefficient steam plants located in almost every municipality. The procedure followed by the Power Board appears to be to go to a municipality or a company which is operating its own steam plant and guarantee to supply power from the Government stations at a price not more than it is costing them with their own plant. We are advised that the results are entirely satisfactory and the general public are now fairly well convinced that the Power Board of Britain is carrying out very successfully the work which it set out to do.

The generating stations are not located at the coal mines, but at points to which coal can be readily shipped by boat. Where large quantities of power are transmitted, high tension transmission is used at a voltage of 132,000.

One of the great difficulties in distributing power in the municipalities in Great Britain is the fact that the people insist that all the wires must be placed underground. This, of course, results in a very high capital cost for distribution system and naturally increases the rates very considerably. The public appears to be very much afraid that overhead power circuits may come in contact with communication wires, or falling on roadways may do damage to persons and property. This fear, of

course, we in this country know to be entirely unfounded as there is no particular danger in carrying circuits on overhead pole lines in this country. and until the prejudice against power conductors on pole lines is broken down the rates to the consumers will remain considerably higher than in Ontario.

Mr. R. C. McCollum, Municipal Auditor, and Mrs. McCollum have just returned from a three weeks' visit to Bermuda. Mr. McCollum's health is very much improved and he is again at his desk. They travelled via Halifax and St. John, and the new Canadian National boats, *Lady Nelson* and *Lady Rodney*, and report a very enjoyable trip, the boats being the last word in spacious comfort for the passengers.

The most interesting report brought back by Mr. McCollum, from a Hydro standpoint, was an account of the local electric service, which has a distribution system covering the entire 22 square miles of coral rock which is Bermuda.

The energy is produced from oil fired boilers, and condensed sea water, there being no fresh water on the Island except the rain water which is collected on the roofs for drinking, cooking and laundry purposes. Energy is sold at a shilling or 24 cents per kilowatt-hour, with a special low rate for domestic appliances, such as pumps, ranges and refrigerators, when separately metered, of 14 cents per kilowatt-hour. An ordinary month's bill for electric service for a 100 room hotel runs about $250.00.

Mr. R. E. Jones, Distribution Section, Electrical Engineering Department, H.E.P.C. of Ontario, was this year awarded the Section Prize for the best paper given at the Toronto Section of the American Institute of Electrical Engineers. The amount of the prize was $20.00, the title of Mr. Jones' paper being "Rural Distribution." Mr. Jones is to be congratulated on the success of his effort.

J. Hossie Thompson

Mitchell, Ont.

On the morning of Wednesday, April 24th, the Town of Mitchell lost one of her most prominent and beloved sons in the death of James Hossie Thompson, after a very brief illness. The late Mr. Thompson was born in Mitchell 50 years ago, a son of the late Walter Thompson, an early pioneer in the district, and since the death of his father carried on a flour and feed business under the name of Walter Thompson and Son.

Mr. Thompson was a firm believer in the principles and a staunch supporter of public ownership, and interested in all matters appertaining to the welfare of the town. Since 1920 he was a member of the Public Utilities Commission, serving as its Chairman for seven years. He was also a former president of the Board of Trade.

The funeral, which took place on Sunday, April 28th, was one of the largest in the history of Mitchell, when the whole populace seemed to have turned out in respect of the

departed. Among those who attended were the members and ex-members of the Public Utility Commission, the Town Council, the local fire company, the Board of Trade and the town band, while the town bell was tolled during the procession to the cemetery.

To his widow, his two sons, Walter and Fred, and his four brothers and two sisters, who survive him, we extend our deepest sympathy.

Universal Safety Broadcast

In the April BULLETIN, we announced a series of radio talks being given on Saturday evenings over the network of the National Safety Broadcasting Company, known as the Universal Safety Series. These programmes are being broadcast at 7.15 p.m. Eastern Daylight Saving Time. Some of the stations participating in the series are WEAF—New York, WEEI—Boston, WTIC—Hartford, WJAR—Providence, WTAG—Worcester, WCSH—Portland, Maine, WGY—Schenectady, WGR—Buffalo, WCAE—Pittsburg, WWJ—Detroit, and WCFL—Chicago.

The remaining programmes of the series, after this month, are announced as follows :

June 1—"Making our Highways Safe." Miller McClintock, Director, Albert Russell Erskine Bureau, Harvard University.

June 8—"Enforcement as an Aid to Safety." Grover A. Whalen, Commissioner of Police, New York City.

June 15—"The Automobile and Safety." (Speaker to be announced.)

June 22—"Safety on the High Seas." Joseph E. Sheedy, Executive Vice-President, U.S. Lines.

June 29—"Safety in the Air." (Speaker to be announced.)

July 6—"Safety and the Worker." Hon. James J. Davis, Secretary of Labour.

July 13—"Summing Up." (Speaker to be announced.)

The Little Switches

The little switches in my home
Are truly friends to me.
A touch on one—and there is light
Where darkness used to be.

Another little switch controls
My heater's cheery glow ;
And one does duty every time
My washer starts to go.

I touch another switch and feel
My fan's cool, bracing air ;
And one I touch when I would have
A warm blast dry my hair.

And there's a switch that operates
The pad that warms my bed ;
And one that gives me current when
I want to toast my bread.

I know that everyone who reads
My tribute will agree,
The little switches in my home
Are truly friends to me.

—G. T. EVANS in *Edison Monthly*.

Largest Chimney in America

The tallest reinforced concrete chimney on the American continent was erected in 1927 at the plant of the Horne Copper Corporation, Noranda, Rouyn district, Quebec. It is 422 ft. 6 in. high from the base to the top of the shaft, and 18 ft. in diameter inside the lining at the top. This height exceeds by 13 ft. 6 in., the previous record height of 409 ft., of two reinforced concrete chimneys erected at Trail, B.C., in 1924-25. The base of the chimney is 883 ft. above sea level, and is supported on a foundation of solid rock. It produces draft for and carries off dust and gasses from four roasting and two reverberatory furnaces, and two converters. Its base consists of a concrete ring 17 ft. 6 in., deep and 35 ft. outside diameter and 23 ft. inside diameter, being steel reinforced, and the shaft, which is designed to withstand effects of acidic gasses within, is for a capacity of 550,000 cu. ft. of gas per minute at temperatures from 300 to 400 degrees Fahrenheit. — *Manufacturing and Industrial Engineering.*

We learn that the International Nickel Co., has under construction at the present time at Copper Cliff, Ontario, a chimney of even greater proportions. This will have a height of approximately 600 ft. and a shaft of approximately 50 ft. diameter. This is for use in carrying off gasses from the smelters.

The foregoing are further evidences of the development taking place in the large mining areas in the Provinces of Ontario and Quebec in Canada.

SUMMER CONVENTION

O.M.E.A. and A.M.E.U.

at

BIGWIN INN

Lake-of-Bays, Muskoka

on

JULY 3, 4, and 5, 1929

Special train will leave Toronto, Tuesday evening, July 2, at 11.00 Standard Time.

Railway and boat fare, $10.00.

Make railway reservations with your local C.N.R. Agent.

Reduced fares from any point for 10 or more.

Hotel rates, $7.00 per day, no extras.

Write Mr. Frank Mahony, c/o Canadian General Electric Co., Ltd., 212 King St. West, Toronto, 2. for hotel reservations.

Motorists drive to Norway Point for ferry to Hotel.

One convention session each day.

Land and water sports, Prizes.

Entertainment for ladies.

BE SURE TO COME.

Hydro News Items

Central Ontario System

The municipality of Belleville is now carrying on negotiations with the Commission for the purchase of the local distribution system and an agreement of sale is now being prepared.

* * * *

The municipality of Oshawa will vote on the purchase of their electrical distribution system and gas plant next June.

* * * *

The Hamilton Cotton Co., will occupy the old factory building of the Dominion Combing Mills in Trenton and will take approximately 600 horsepower.

* * * *

Over 20 miles of rural line are now being constructed in the Belleville Rural District and about 10 miles of additional line is probable in the near future.

* * * *

The Campbellford Rural District has for many years remained stationary as the municipality of Campbellford has operated a number of private lines in the district. Increasing density of customers on the existing lines has resulted in a considerable reduction of rates and about five additional miles of line will be built this summer.

* * * *

Niagara System

The present capacity of Caledonia Distributing Station is being increased by the addition of 1—300 kv-a., 3-phase transformer.

The increased capacity is rendered necessary by a substantial growth in the consumers in the Caledonia R.P.D., together with the normal increase in the load taken by the Village of Caledonia.

* * * *

A new Distributing Station has been completed near Vinemount in Saltfleet Township. This is fed by a new 13,200 volt line which is being constructed from Hamilton Station, the distance being approximately 10 miles. It will supply power to a large quarry in the vicinity and will also supply the easterly section of Saltfleet R.P.D., the load in the Saltfleet District having grown to such an extent that the present rural Station near Hamilton Station is loaded to capacity.

* * * *

Four 1,500,000 kv-a. rupturing capacity breakers are being installed on the 110 kv. lines at the Bridgman-Davenport Transformer Station, Toronto, replacing smaller breakers. At the Wiltshire Ave., Transformer Station, a fourth bank of 3, 5000 kv-a. transformers is being installed, together with the necessary extensions of steel structures and oil and water systems.

* * * *

Arrangements are under way for the erection of a 13,200 to 4,000 volt substation on a site facing the Weston

Road about 3/4 miles north of the Town of Weston and a short distance south of Albion Road, the site chosen being in a sub-division in North York Township known as Albion Park.

The station will be the semi-outdoor type with two 300 kv-a., 3-phase transformers placed outside, the 13,200 volt and 4,000 volt wiring as well as the 13,200 volt disconnects and protective equipment being carried on a galvanized steel structure.

A small brick building is to be erected to house two 4,000 volt feeder panels each carrying an oil switch together with ammeters, a curve-drawing kilowatt demand meter and a curve-drawing reactive kilovolt ampere meter. One of these feeders will serve the Thistletown district of Etobicoke Township with an initial load of about 250 h.p. The other will serve the section of North York Township adjacent to Weston, the initial load expected being about the same as on the Etobicoke Township feeder.

Power will be delivered to the station over a branch line about one mile long, tapping the 13,200 volt circuit from York Station which feeds stations at Islington, Weston, Woodbridge and Kleinburg.

* * * *

Ottawa System

Work has been commenced on the erection of a 110/11 kv. transformer station on the site of No. 3 substation of the Ottawa Hydro Electric System. This station will have an initial capacity of three 3,000 kv-a. transformers with one spare unit. All equipment will be installed outdoors and it is expected that the station will be completed about October 1st next.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE

BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Double Circuit, 110 kv. Line from Niagara River to St. Thomas.

CONSTRUCTION was completed, and the equipment placed into service during the week-end of June 8th, of the new double circuit 110,000-volt steel tower line from the Niagara River to St. Thomas. This work was started late in 1928, and has been carried through continuously since that time, except for about a month in the spring when the weather conditions rendered the line almost inaccessible,

The towers are normally 97 feet high overall, spaced approximately 5 towers to the mile. The standard tower weighs 12,800 lbs., the total weight of steel being of the order of 7,000,000 lbs.

The power conductor on the line is steel-reinforced aluminum, 605,000 cir. mils in area, or .953 inches outside diameter. This conductor weighs approximately 4,200 lbs. per mile, the total weight of power conductor in the two circuits being 2,650,000 lbs. The ground conductor is 5/16 in. galvanized steel cable.

Lines of this type of construction cost approximately $16,000 per mile, representing a total expenditure of the order of one and three-quarter million dollars. It appears that the cost of this line will be well within the original estimated cost.

These circuits provide a direct supply from the generating stations on the Niagara River to the St. Thomas Transformer Station, and from there to the stations west. They will enable an arrangement of the 110,000-volt systen to be made, whereby the transformer stations west of Dundas will be split into two separate sub-systems, the stations between Dundas and London, *i.e.*, on the "Loop", in one sub-system, the western stations on the other. Voltage requirements of both sub-systems may then be regulated independently at the generating stations, enabling the conditions required at a distant station, for instance at Kent or Essex, to be more nearly met, without conflicting with the requirements at a

CONTENTS

Vol. XVI **No. 6**

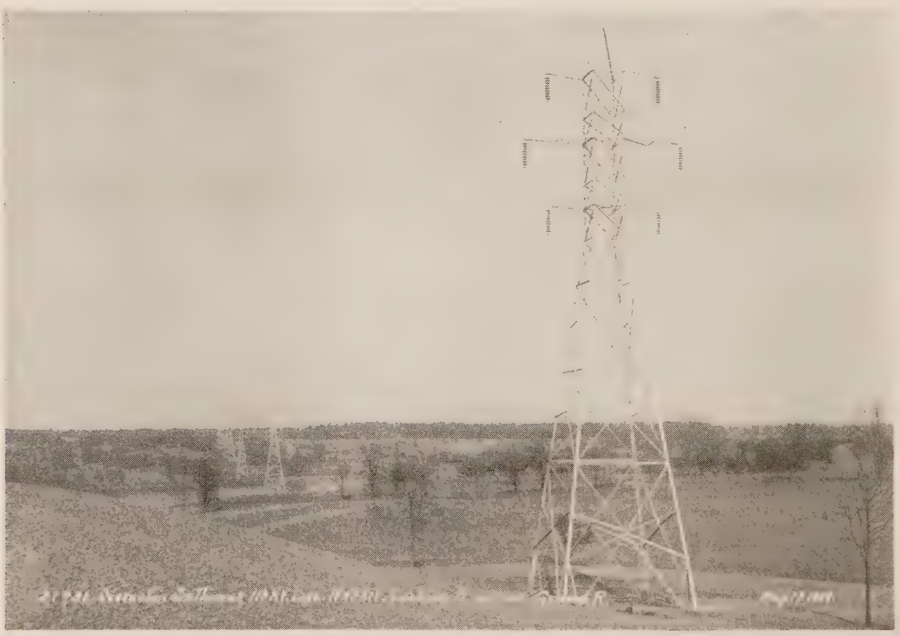
June, 1929

	Page
Double Circuit, 110 kv. Line from Niagara River to St Thomas	181
Setting Poles by Dynamite at Wasaga Beach	183
Eugenia Hydro-Electric Association Meeting	186
Application of Hydro to Rural Electric Service	187
Old Mills and Water Power Drives in Ontario	189
Kingston Billing System	191
Flood Lighting London P. U. Com. Building	195
Some Problems in Engineering Research	196
The Other Fellow's Job	200
The Relation of Science to Industry	204
New Values in Industry	210
Lighting Hens in Winter	213
Hydro News Items	217

near station, say Guelph or Brant. The improvement in operating conditions under this new arrangement will be of great benefit to all these stations.

While these sub-systems will normally be separate, the tie between London and St. Thomas will always provide an emergency connection, enabling the reserve capacity of the "Loop" lines to assist the west in times of trouble, or vice versa.

This new line is 105 miles in length, from the east bank of the Welland Canal at Allenburg to St. Thomas. At the former point it connects to existing circuits for connection into the generating stations.



Queenston-St. Thomas 110 kv. line, looking east across Grand River.

Setting Poles by Dynamite at Wasaga Beach

By D. T. Flannery, Municipal Engineering Dept., H.E.P.C. of Ont.

THE rising waters in the Great Lakes have encroached on Wasaga Beach, one of the most popular summer resorts on Georgian Bay, to such an extent that the famous motor speedway along the beach has practically disappeared. *Fig.* 1 shows a light which was erected at the turn from the beach to Elmvale for the guidance of motorists not familiar with the district, and when it is pointed out that the route of motor traffic was some seventy-five feet from this pole some idea may be gathered as to the effect of the high water.

This summer resort has had the advantage of electric service since the summer of 1923, being served by a line from the end of the Stayner distribution system where the voltage is transformed from 4,000 to 8,000 volts.

Fig. 1—The road is gone, only the light remains.

When the construction of lines along the waterfront was undertaken an effort was made to secure information as to the high water marks along the shore and the pole line was located well up on a sand ridge considerable distance from high water.

Due to the combination of high water and strong winds during the spring, the shore line gradually receded, with the result that the pole line was dangerously close to the water's edge.

On May 16th a very high wind from the north-west arose and reports were received that a number of the poles were leaning badly. An effort was made to support these poles temporarily, as shown in *Fig.* 2, and while a number of poles were saved from falling, it was impossible to protect the entire line, and when the storm subsided some fifty poles were down and a great number undermined as shown in *Fig.* 3.

The fence posts, visible in *Fig.* 3, have been exposed to view for the first time in many years. Enquiries among the older residents of the district disclosed the fact that this fence originally was part of an enclosure used for pasture lands.

A careful study of the situation was made and it was decided to reset the poles which were down or undermined in their original locations, observations having indicated that future storms would tend to build up the beach rather than to wash away additional sand.

Fig. 2—Undermined pole with temporary supports.

was readily seen that other methods would have to be devised.

Some months ago the Technical Press had a brief notation to the effect that poles were being set through swamp lands in Florida by means of dynamite, but no details as to the procedure followed were given. As it was essential that service be resumed as speedily as possible, it was decided to carry out some experiments with dynamite.

Six sticks of 60 per cent. stumping powder were secured and preliminary experiments carried out which proved that poles could be successfully set by this means.

The procedure which was finally adopted was to dig a hole approximately twelve inches deep and then

A construction crew was rushed to the scene, but due to the proximity of the water, it was found impossible to dig to a depth of more than twelve to eighteen inches before trouble was experienced with sand and water flowing into the hole as rapidly as it was excavated.

Wooden barrels and standard steel digging shields were employed but did not overcome the difficulties encountered, as the barrels collapsed under the pressure and it was almost impossible to remove the steel shields once the hole was dug to the required depth. Four sets of blocks were used and it was finally necessary to fasten the rope from one set of blocks to the truck before the shield could be removed.

The net result of the first day's operation was three poles erected and as the task involved the resetting of approximately four miles of line it

Fig. 3—Undermined pole, fence was completely buried for many years.

force a seven foot length of 1¼ inch pipe in the wet sand to a depth of six or seven inches.

The pipe was then filled with water and by means of a ¾ inch pipe the sand and water pumped out. As the sand and water was pumped out it was found that the 1¼ inch pipe could be forced by hand to its full depth of seven feet.

One stick of dynamite and three sticks of 60 per cent. stumping powder were inserted in the 1¼ inch pipe and held in place by means of a wooden rod while the pipe was withdrawn. This left the charge in the wet sand approximately five feet below the surface.

The pole which had been roughly pointed at the butt with an axe was then erected directly over the charge and held in position by means of rope guys attached to the top and running in four directions.

When the charge was fired, the pole rose vertically from six to twelve inches and then settled in the hole to a depth of approximately six feet.

It was necessary then to line the pole up with the others immediately, as the wet sand soon flowed back around the pole, making very little back-filling necessary.

Fig. 4 shows the result that may be expected from this procedure. In taking this photo two exposures were made on the one negative, the first with the pole set on the ground directly over the charge, and the second immediately after the charge was fired. The difference in the elevations of the cross-arm indicates the depth to which the pole settled.

The procedure outlined proved most satisfactory, and enabled night

Fig. 4—Double exposure photograph showing pole before and after firing charge.

service to be resumed on the sixth evening after the storm. When it is taken into consideration that by digging it was impossible to set more than three or four poles per day, this may be considered in the nature of a record.

While most satisfactory results were obtained in resetting poles which were washed out entirely, difficulties were encountered when an attempt was made to lower poles which had not been entirely undermined but which were left standing with two or three feet of the pole in the ground.

After making several experiments in resetting poles which were left standing, it was found that the most satisfactory method was to remove the poles entirely by means of a pole jack and set as described in this article.

In conclusion it may be pointed out that where flowing sand or quick sand is encountered, poles may be set far faster and most economically by means of dynamite, where due precautions are taken. One of the most

essential precautions is to use two detonator caps in each charge to ensure an explosion of the charge.

Eugenia Hydro-Electric Association Meeting

The annual meeting of the Eugenia Hydro-Electric Association was held this year on June 12th at Eugenia Falls and the representatives of the various municipalities were the guests of the Hydro-Electric Power Commission at both luncheon and dinner in the evening.

The executive Committee held its regular meeting during the morning, and the general meeting of the Association was held at the pavilion in the park during the afternoon. Mr. C. J. Halliday of Chesley was elected President of the Association and Mr. W. H. Gurney of Wingham, 1st Vice-President, and Mr. C. C. Elvidge was re-elected as Secretary Treasurer. Dr. G. S. Fowler, of Teeswater, the retiring President, was elected to the Executive as well as Mr. F. W. Bourn of Grand Valley, and Mr. S. Armstrong of Hanover. After the Secretary-Treasurer's report was read both the retiring President and President elect addressed the meeting and reviewed the progress of Hydro in the district, stressing the advantage of public ownership. Both speakers appealed for the support of all the municipalities in carrying out the Hydro policy throughout the district and emphasized the necessity of all of the municipalities working together for the good of the common cause.

After the general session had adjourned, an inspection was made of the dam, head works, pipe lines and generating plant of the Eugenia Development, which was followed by an open-air dinner in the park. After the dinner, the Resolutions Committee made its report through its Chairman, S. F. Ballachey of Paisley, and the meeting was addressed by Mr. T. C. James of the Municipal Engineering Department of the Commission concerning future power development for the district, and by Mr. Wills MacLachlan on Accident Prevention. On the whole, the meeting was entirely successful, and the various delegates expressed themselves as well pleased with the results of same.

The open air sessions in the Eugenia Park and the inspection of the Eugenia Development made an ideal setting for a gathering of this kind, and representatives of the various municipalities were able to obtain a close-up impression of the development from which the entire district is served.

Application of Hydro to Rural Electric Service

Chopping Mill, 10 h.p. motor driving 15 in. single-head chopper.

AFTER the flood conditions in the middle of April, a number of requests were received for temporary or permanent service to mills which had suffered by having the dams break at one or more points. One of these applications was for permanent electric service as an auxiliary to the water power in the Bruce mill north of Unionville in the Markham rural power district. It is claimed that there is 24 horse-power available from the water power with a 16-foot head. This head, of course, varies with the levels in the pondage. The mill has been in operation for over 90 years and the power up to the present time has always been supplied by water.

As the Commission had only a single-phase line to this property giving service for lighting and domestic uses in the house and lighting in the mill, the other wires of the three-phase line being more than four miles away, we advised that in order to have service supplied at once, it would be necessary for the mill to

Fig. 1—Corner in mill showing the motor installation.

confine the uses to those which could be supplied single-phase. It was recommended that a 10-horsepower motor be installed, belted direct to the 15-inch chopper as a temporary arrangement to tide them over in an emergency until the dam was repaired and that a 5-horsepower motor be installed to drive the elevators and cleaners which are used for cleaning seed, grain and wheat for the flour mill. Later this motor is to be installed in a permanent location so that it will drive to the main line shafting working with the water wheel.

This is the first installation we know of in Ontario where a 10-horsepower drive has been applied to a 15-inch chopper. In this case it was recommended that for the temporary service at least the chopper be driven at a speed of about 1,500 rev. per min. The motor pulleys available resulted in finally driving the chopper at 1,700 rev. per min., although this did not meet with the approval of the miller who thought he should have a speed of at least 2,500. However, when ready to operate, he did not hesitate to start with the chopper being driven at the lower speed. Later in order to try it out at 2,500 rev. per min., he secured a pulley, which would give this speed, but after a test of a few hours, changed back to the pulley secured with the motor and continued operating at 1,700. He reports that the output is fully as high driving this way as he has ever had from his 24 horsepower water wheel. Some of this, of course, is due to the elimination of line shafting drives but a great deal of it is due to lowering of the chopper speed. For 10 to 12 kilowatts imput to the chopper motor alone, the output of fine chop was reported as one ton per hour and on a one-day run resulted in this average being maintained throughout the period. The grain chopped during that day was oats and western screenings.

Cuts of this mill, water wheel and dam appear in connection with the article on old mills in Ontario, in this issue. *Fig. 1* shows a corner of the mill with the two motors in location, the 5-horsepower on the ceiling being permanently installed and the 10-horsepower to the left of the chopper being in a temporary location.

Old Mills and Water Power Drives in Ontario

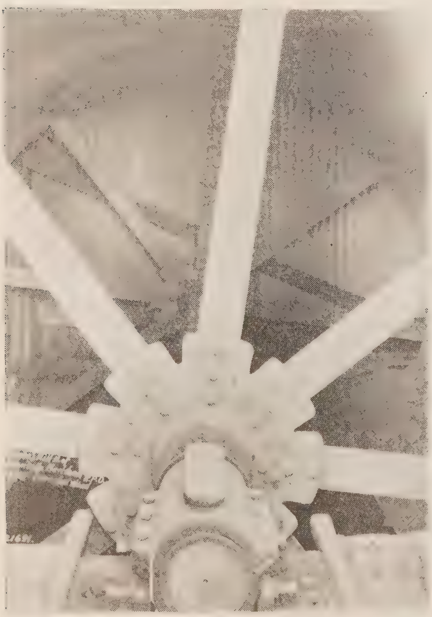
THERE is a most interesting variety of power drives for milling purposes in Ontario, most of which were deloped between 75 and 100 years ago. This variety includes old waterwheels of the overhead and undershot type, in some cases using two heads, the power from the second development being transmitted to the mill proper by a cable drive suspended in the air from a tower above the waterwheel to one of the upper counter-shaftings in the mill, this giving ample clearance between roadway and the cable drive.

The mill which is the subject of this article, had originally, it is believed, an undershot wheel later superseded by the turbine and about fifteen years ago again superseded by the present wheel which is an overshot 12 feet in diameter by 8 feet in width. This type of wheel has been manufactured and supplied to users in Ontario for about 75 years. *Fig. 2* shows the exterior of the wheel; the bottom sides of the buckets are fastened to the drum and have two partitions for stiffening purposes. The reason given for the change from the turbine to the overshot wheel was the necessity for added power and it is stated that the results justified the change. *Fig. 3* shows the interior of the wheel.

As a result of the flood conditions in the middle of April this year, the dam had washouts at three points and as there was a single-phase electric service on the property, arrangements were made by the owner to introduce electric drive to

Fig. 1.—The old portion of this mill was built 92 years ago and there is still running as an elevator belt in this mill one of the original belts, full of holes, very flexible, but giving perfectly satisfactory service. Another belt on the line shafting drive has been in use for over 50 years.

Fig. 2.—The overshot wheel, 12 ft. by 8 ft. This is a metal wheel, installed about 15 years ago. The type, however, is the same as found in many other places used for over 70 years. Especially is this type found in Waterloo County.



supersede the water-power temporarily for chopping and grain cleaning purposes, later using this service in conjunction with the water power for the driving of the mill, which has as a business commercial chopping and the making of a special flour for hospitals and public health institutions. The present manager, Mr. Bruce, expresses himself as being eminently satisfied with the results obtained to date and that these results more than justify the introduction of electric service into the business.

Fig. 3.—The interior of the waterwheel, showing the closed drum, the shafting, spokes and one bearing.

Fig. 4.—The dam and pondage, showing the breaks at three points, the river now flowing in a course that it has never taken before, having during the flood eaten through a bank 18 feet high and approximately 75 feet to the old river bed.

Kingston Billing System

By H. L. Summerlee, Burroughs Adding Machine Company, Detroit, Mich.

THE Public Utility Commission at Kingston, Ont., serves 6,100 electric and 4,500 gas customers, billing monthly. The city is divided into ten districts—each district has a final discount date. This arrangement provides an even flow of work for the meter readers, billing department, cashier's office and cash posters as the work is divided evenly through the month. A more uniform cash balance is maintained due to the ten final discount dates; better service to the customer is possible as less errors are made due to the work not being done in a rush at the end of the month.

The meter readers write the new meter reading only in the meter reading books. The present reading is transcribed in the Accounting Department to an intermediate card, which has columns for the reading date, electric readings, electric consumption, consumption charges at the first and second rates, gas readings gas consumption and gas charges. The first entries are made starting at the bottom of the form, which places the larger number above the smaller. The subtraction is made easier by this arrangement.

A pre-billing clerk calculates the consumption and enters the amount in the consumption column. The service charge, which remains constant, appears at the top of the column provided for the consumption charge at the first rate and the consumption charge at the second rate plus the service charge is entered at the top

		READING	Consumption	Service Charge 33	Constant 158	GAS READING	GAS Consumption	17
DEC.								
NOV.								
FEB.								
1931 JAN.								
DEC.								
NOV.								
MAR.								
FEB.	4	2092	70		30			
1930 JAN.	4	2022	40	100		262	13	203
Previous Reading		1982				249		

Meter Record

of the column provided for the consumption charge at the second rate. The residence electric light schedule is based on 2½c. per kw-hr. for the first fifty kilowatt-hours used per month and the balance of the monthly consumption at 1½c. per kilowatt-hour, plus the service charge of 33c. for ordinary lighting service or 66c. monthly service charge if the permanently connected load exceeds 2,000 watts. The gas rate is $1.56 per 1,000 cu. ft., per month, plus a meter rental charge of 17c.

If the electric consumption was for example, 40 kw-hr., $1.00 would be entered into the column for the consumption charge at the first rate. The gross bill is then calculated by adding $1.00 to the service charge of 33c., which was entered at the top of the column. If the consumption was found to be 70 kw-hr., the difference of 20 would be referred to a chart on which the consumption in excess of 50 kw-hr. is pre-figured. In this case the consumption charge at the second rate would be read from the

Kingston Public Utilities Commission
19 QUEEN STREET

DOMESTIC

Date	Dept.	Meter Readings: Present	Meter Readings: Previous	Consumed Elec.—K.W.H. Gas—100 C.F.	Service Charge Gas Meter Rent	Consumption Charge @ 1st Rate	Consumption Charge @ 2nd Rate	Gross Bill	Net Bill
NOV 3		4053	3856	197	66	125	221	412	371
NOV. 3		262	249 GAS	13	17 GAS			220	198 GAS
									569 TOT

DOMESTIC
Last Discount Date

Gross	Net
412	371
220	198 GAS
	569 TOT

Office Hours:
9 a.m. to 5 p.m.
'Phone 844
Errors and Omissions promptly rectified at office.

MAIL STUB ONLY IF PAYING BY CHEQUE
All Cheques must be payable to
Kingston Public Utilities Commission.
Positively No Discount after date shown.
READ RULES OTHER SIDE

OFFICE STUB
KINGSTON PUBLIC UTILITIES COMMISSION

Bill and cashier's coupon covering both electric and gas service.

chart as 30c. and entered in the proper column. The amount of $1.58 built up of 50 kw-hr. at 2½c. plus 33c. service charge appearing at the top of the column is added to the 30c. to calculate the gross bill. The gas charges are figured in the same manner with the exception that only one rate is involved. The intermediate cards are then forwarded to the Billing Department.

A Burroughs Public Utility Billing Machine is used, which writes the bill and cashier's coupon, posts the ledger and makes the recapitulation sheet at one operation. The bill, which has been previously addressed by an addressograph machine and the ledger are dropped to the correct writing lines without being positioned by the operator. The present meter reading date is set up on the keyboard of the machine but once and thereafter prints automatically in the proper location on the bill and ledger. A recapitulation sheet is inserted for each batch of accounts and shows all of the information, which appears on the customer's bill. At the first operation, the present electric reading is printed on the ledger and without any further effort on the part of the operator, the present electric reading date, the present electric reading and the previous electric reading, automatically print on the bill. At the next operation, the electric consumption and service charge are printed.

AREA, FEET		
" CHARGE		
INSTALLATION		
	K.W.H.	AMOUNT
MINIMUM		
1ST RATE		
2ND RATE		
TOTAL		

DATE	GROSS	NET	CREDITS	BALANCE	READING
			BROT. FORWARD		
NOV 3	4 12	3 71			4053
NOV 3	2 20	1 98 GAS			2 62

	METER NO.	INSTALLED	READING	MAKER	SIZE	VOLT	REMOVED	READING
ELEC.								
GAS								

Ledger card printed at same time as bill.

At the following operation. the consumption charges at the first and second rates are printed. The gross and net electric charges are printed at the next operation, automatically repeat printing on the cashier's coupon and the ledger. The carriage automatically moves so that the figures are printed under the proper headings. After printing the electric gross and net charges on the ledger, the carriage is in position to print the gas readings below the electric readings. A gas account is billed similar to an electric account except that nothing is printed under the consumption charge figures and that the word "gas" is printed automatically after the gas readings, gas meter rental and the gas gross and net charges to identify the gas items from the electric. The carriage is returned mechanically after printing the gas gross and net charges on the ledger, to the position where the charges are printed on the bill. Miscellaneous charges such as uncollected items and merchandise charges may then be posted. Characters are printed by the machine to identify these charges to the customer. These charges are printed on the bill, automatically repeat printed on the cashier's coupon and are mechanically non-printed on the ledger. It was not desired to have miscellaneous charges print on the ledger as the uncollected items are already in the balance column of the ledger and separate ledgers are maintained for merchandise accounts. Each bill having more than one line is totalled by the machine. The symbol "TOT" is printed automatically to the right of the total. A credit due to a customer because of an over-reading or adjustment can be subtracted from the debit charges and a total of the net difference printed. The total charges are also non-printed on the ledger.

After printing the total of the charges on the bill and cashier's coupon, the carriage opens automatically, permitting an easy removal of the forms posted and the insertion of the bill and ledger for the next account.

The figures which have been printed have also been accumulated by the machine. These accumulations are used to prove the billing and to establish the current debit for the control ledger. The totals of twelve important billing factors are accumulated. These totals are—total of the present meter reading, total of the previous readings, total kilowatt-hours consumed, total of the service charges, total of the consumption charges at the first rate, total of the consumption charges at the second rate, total of the gross electric revenue total of the net electric revenue, total of cubit feet of gas consumed, total of the gas meter rentals, total of the gross gas revenue and the total of the net gas revenue. The total of the electric consumption plus the total of the gas consumption added to the total previous readings is balanced to the present readings thus proving that the readings and consumption printed on each bill is in balance. The consumption charges are reduced to kilowatt-hours and balanced to the electric consumption. The service charges plus the consumption charges equal the gross charges. The total net revenue is 90 per cent. of the gross charges. The total gas consumption

is multiplied by the rate and added to the gas meter rental balancing to the total of the gross gas revenue.

The total consumption and revenue are obtained from these totals for statistical purposes making it unnecessary to secure this information at a separate operation.

The net revenue is taken into Accounts Receivable as the majority of the bills are paid net. Approximately five days after the discount period when the delinquent list is made of the uncollected items a trial balance is taken. The gross amount of the uncollected items is extended to the balance column on the ledger. The Accounts Receivable is then debited with the difference between the gross and net charges of the uncollected items. If the gross revenue had been taken into Accounts Receivable, it would have been necessary to credit Accounts Receivable with the difference between the gross and net charges of all bills paid during the discount period. Balancing each district as a unit, a short time after the discount period, is much easier than attempting to balance all of the accounts at one time.

The billing machine has proved to be of great assistance to the Accounting Department and the bills have caused favorable comment to be made by the customers due to the neat appearance of machine written figures.

Floodlighting London P.U. Com. Building

The floodlighting of the Public Utilities Commission building in London, Ontario, presented a number of difficulties. None of the near-by buildings could be made use of, and if they could have been used, trees on the short side of the building would have made it impossible.

The building itself is of grey stone and is very well adapted to floodlighting. Circumstances made it necessary to combine floodlighting with street lighting and the unit used

was specially designed to meet those requirements.

The average intensity of light on the building is twelve foot candles, which makes it, possibly, the best example in Canada of floodlighting an entire building.

The complete installation was by Powerlite Devices, Limited, of Toronto.

Some Problems in Engineering Research

By W. B. Buchanan, Assistant Laboratory Engineer, H.E.P.C. of Ont.

(*Read before Toronto Section, A.I.E.E., March 25, 1927.*)

THE manner in which problems are presented varies a great deal. First we have the unceasing "why" of the child that has been stimulated and repressed in various degrees ever since the time of Adam. The primitive instinct of self-preservation first, then of pleasure, prompts us to develop facilities by means of which we can compel nature to minister more fully to our needs than we have been able to do in the past. The progress made due to these motives has led to various forms of co-operation on a very large scale, wherein very highly specialized effort is required of the individual if the boundaries of organized knowledge are to be advanced.

Considering the origin of engineering research problems it seems natural that the greater majority would be derived from the operating field where advanced engineering practice is carried on. Such problems have qualities desirable from the investigator's point of view, *viz.*, wholehearted co-operation from those concerned in the investigation, prospect of immediate benefit and recognition of results obtained and generally a definite and sufficiently liberal program of financing the same. Frequently, however, a practical solution is only approximate and the necessity of immediate decision and action leaves many questions unanswered. Some of these bypaths lead to valuable results but many do not and it is often an open question whether a suggested study is warranted or not. The record of the last year's work of the section of the Laboratories of the Hydro-Electric Power Commission which is devoted to high tension and general electrical testing, will give some idea of the nature of the research work carried on. The magnitude of the work and the percentage division into types has been approximately the same for the past four or five years. Eighty-two work orders covering groups of tests could be classed as routine and be carried out by trained test men of proper qualifications using standardized methods. Thirty-two investigations required methods of test not yet standardized and from a couple of days to three or four weeks for completion. Some fifteen investigations were carried on at the same time of a larger magnitude and of the nature of a continuous programme.

The request for assistance varies in its character with the types of

problem presented. Instructions for standardized methods of test can be made definite and leave little to the resourcefulness of a test engineer. A request to determine the fitness of a proposed device to perform the duty demanded of it requires a study of its operation under both normal and abnormal conditions and the application of such tests as will conclusively demonstrate its various qualifications for the purposes proposed. The more difficult of the problems however, are those which are listed simply as "trouble" and the onus is on the investigator to collect all information, diagnose the case and present conclusions. Facilities for solving such problems as the latter give any institution a warranty in using the word "research" as part of its official title. The obvious meaning of the word implies that it involves a re-examination of the fundamental principles on which standard practice is based and to point out the limitations involved, also to point out new fields of application.

The first problem that presents itself to the mind of an investigator who is undertaking a new problem is a choice of method. He may be content to "browse around" for a time but without some definite direction this does not guarantee success nor even satisfactory progress and for his own personal satisfaction he wants some assurance of results. It is comparatively easy to follow along lines of standard tests such as are outlined in familiar text books, but these methods are usually limited to such sections of the general problem of research as the compilation of data, and are limited in their scope. A cut-and-try method might be used to obtain some information from which a systematic method of procedure could be devised but as a scientific method it is generally too expensive to carry far, also uncertain. Other methods occur instinctively to the engineer perhaps more readily on account of his mathematical training such as elimination of irrelevant factors, substitution or control of those not eliminated, grouping mutually dependent parts, segregating independent parts or groups, etc., but these in general only form part of a larger scheme though often very essential to a satisfactory solution. As a basis for training in engineering research we can hardly stress too strongly the necessity of a fairly thorough knowledge of the elements of the physical sciences, quantitative as well as qualitative, familiarity with mathematical analysis and facility in using methods suggested by the latter with all various degrees of complexity.

Practically every problem requiring investigation may be divided for the purposes of our analysis into three parts :—

(*a*) The law or laws of nature we wish to determine, and which we assume to be permanent in character.

(*b*) The connecting link between these laws and the intelligent consciousness of the observer.

(*c*) The capacity and other qualifications of the observer to faithfully notice, record and interpret the phenomena of (*a*) as presented by (*b*).

Possibly the only assumption that the student of applied science is asked to make is that nature is consistent, that natural laws assert and repeat

themselves with unquestionable fidelity to themselves and to the materials upon which they operate. Some theologians may not admit of such an assumption but the weight of evidence as we see it, is overwhelming on the side of its being true and the thorough student of science soon realizes that there must be many laws and natural phenomena which will always be beyond the understanding of a finite mind and consistency demands that he place so-called supernatural phenomena in this category.

Considering the connecting links it is evident that the physical senses of the observer must be supplemented by a great variety of instruments of types and ranges extending to limits only determined by the investigations under way. Quantitative results necessitate the adoption of definite standards of value and to be satisfactory, instruments should conform to accepted standards. In many cases instruments may be very crude in construction and in operation as well, and errors of 50 per cent or more may not be objectionable while in other cases the most refined instruments are required and errors of one-tenth of one per cent cannot be tolerated. Out of the almost unlimited range of testing equipment and measuring available in modern laboratories, an investigator must then select those which will indicate the quantities he wishes to study within the permissible limits of error. In this step he must rely on the ability and skill of expert technicians and he becomes conscious of the limited capacity of an individual to solve any intricate problem single-handed and of the advantages to be derived from co-operation.

The various factors entering the personal equation are probably the most complex and elusive. Starting with the decision that something is to be done along the line of investigating a problem in applied science or business administration, personal tastes as well as previous training and experience serve to dictate the plan he may adopt. Personal tastes are likely to be affected to a very large extent by such factors as,—imitation; a subconscious and possibly a conscious reverence for standard practice, dogma or authority ; unwillingness to admit evidence tending to disprove some favorite theory ; laziness, cupidity and personal egotism. Dogma or authority carry no more weight with a thorough going scientist than those elements contain of the fundamental truths for which he is searching. Imitation is a natural impulse and it generally serves to make our progress easy but an imitator must be satisfied to spend his time in fields that have already been explored and original work is rather outside his scope. Standard practice is a haven of refuge for consulting specialists and is entitled to due respect from everyone but it is not in the forefront of engineering development and does not always provide for the special features that are inherent in extending the applications of apparatus.

Incentive of some nature is necessary to stimulate and maintain interest in the subject and ensure a satisfactory solution of the problem. Previous training and experience also tend through force of habit to prompt an investigator to follow along lines previously laid out and in proportion as he has become wedded to such

methods he is likely to lack in individual initiative and resourcefulness.

An investigator should recognize the effect of these tendencies in himself and if he makes use of the assistance of others, he will find it necessary to make due allowance for the human factors involved.

Given a problem, the personnel and the facilities with which to operate, the question then arises,—how to start. We will doubtless be forced to admit that no general method is yet available. A very close parallel, it seems to me, is the problem of a woodman when splitting rails or blocks of wood. He turns the stick over and inspects it carefully. Previous experience suggests to him where the most satisfactory cleavage lines may be found and he plans his strokes carefully. Sections of curly butt blocks of elm or birch he may have to slab off little by little ; with other blocks, he may find the easier splits straight through the heart and others again will not split at all but must be cut away entirely.

Then again an aggressive military man like Alexander the Great may decide to cut his way through the heart of a problem, one of a mathematical turn tries to analyze while another organizes a committee and under the guise of co-operation, gets someone else to do the work. All these methods and many others are necessary and may also be used by a single investigator according to the type of problem in hand.

If the problem be of some standardized type, the question of method gives little trouble but as stated previously, this is limited practically to routine testing. A problem of a pioneering nature gives us the greatest difficulty. It is important to learn what has been done on the approches to the problem, to determine to what extent the results already obtained are reliable and if necessary to repeat much experimental work in order that an absolutely sound basis be laid for future progress. Knowledge begins with a vague blur, which becomes distinct through analysis and one characteristic of a trained mind is to be able to detect finer shades of difference than are visible to the multitude. As one becomes more acquainted with the details of a special branch of science, a more rigid use of the terminology must be adopted. An ability to express exactly the result of his experience and findings is a very necessary part of the equipment of an investigator who hopes to co-operate successfully with others in his field.

Inasmuch as the investigational problems and methods found useful by us in the electrical field lie anywhere between those of standard engineering practice and those of pure physical research, it was felt that on the one hand the value of the results obtained could be increased by pointing out the method of solution in any given case and conversely, various methods of attack could be illustrated very clearly by reference to the problem and the results obtained. It might be noted here that formal logic does not make discoveries but has its greatest value in checking the accuracy of results after they have been obtained. The following general steps should be listed :

Collection of preliminary data on the problem.

- Inspection and classification of the data.
- Grouping mutually dependent parts.
- Segregating independent parts.
- Checking or testing on doubtful points.
- Elimination of independent variables.
- Control of dependent variables.
- Analysis and extension of observations by deduction.
- Formulation of hypothesis by induction, synthesis.
- Check tests on the new or revised theory.

With respect to these various steps, many factors must be taken into account.

Time may be lost looking for data on subjects for which no reliable data has been compiled. On the other hand unnecessary duplication of perfectly good results should be avoided. Much data has only a local value and is useless anywhere else, *e.g.* an assumption as to ground resistance may result in hazard to equipment. Some very elaborate data is published and possibly a most important item left out, *e.g.*—the D.C./A.C. puncture voltage ratio is obtained on several classes of materials but the frequency of the a.c. supply seems to have been omitted from the records.

From this brief enumeration of some of the elements involved in engineering research, it will be evident that it is rather a highly specialized branch. While we may admit and like to feel that every man engaged in engineering has a natural aptitude for and enjoys investigation to a limited extent, it will also be clear that the more efficient scheme for progress involves co-operation with those who are already well acquainted with up-to-date practice and are familiar with methods and equipment which will bring about further advances in the art as required to meet changing conditions.

"The Other Fellow's Job"

By Charles L. O'Loughlin Blackstone Valley Gas & Electric Company

We are spinning our own fates, good or evil, never to be undone. Every smallest stroke of virtue, vice or idleness leaves its never-so-little scar. The drunken Rip Van Winkle, in Jefferson's play, excuses himself for every fresh dereliction by saying, "I won't count this time."

Well, he may not count it, and a kind Heaven may not count it ; but it is being counted none the less. Down among his nerve cells and fibres the molecules are counting it, registering and storing it up to be used against him when the next temptation comes.

Nothing we ever do is, in strict scientific literalness, wiped out. Of course, this has its good side as well as its bad one. For just as men become permanent drunkards by so many separate drinks, so do they become saints in the moral, and authorities and experts in the practical and scientific spheres, by so

many separate acts and hours of work.

Let no youth have any anxiety about the upshot of his education, whatever the line of it may be. If he keep faithfully busy each hour of the working day, he may safely leave the final result to itself. He can with perfect certainty count on waking up some fine morning to learn that he is one of the competent men of his generation in whatever pursuit he may be singled out. Silently, between all the details of his business, the power of judging in all that class of matter will have built itself up within him as a possession that will never pass away.

Young people should know this truth in advance. The ignorance of it has probably engendered more discouragement and faint-heartedness in youths embarking on arduous careers than all other causes put together.

This world of work is like a looking-glass that gives back to every man the reflection of his own face. Frown at it, and it in turn will look sourly upon you ; laugh at it and with it, and you will find it a jolly, kind companion.

The man who starts out with the idea of getting rich wont succeed ; he must have a larger ambition. There is no mystery in business success. If we do each day's task successfully, stay faithfully within the natural operations of commercial law, and keep our heads clear, we shall come out all right.

There are two kinds of discontent in this world ; the discontent that works, and the discontent that wrings its hands. The first gets what it wants, and the second loses what it has. There is no cure for the first but success and there is no cure at all for the second.

No matter what job we have, the chances are it isn't a good one. Not half so good as we deserve. You'll admit it. There are things about it that looked attractive to us before we got it, but since we have it and have looked around us, Good Night ! If we had known this and that and the other thing about it, wild horses couldn't have dragged us into it.

But there is one job we would like —its the one another fellow has ! If we had that job we'd be happy ; and the job itself would be looked after a great deal better than this other nut is looking after it. Why, that guy doesn't know when he is well off ! Kicking about his job all the time. Good Night ! If we had it we'd know what to do about it. We would settle right down and be contented in it.

Yes, but did you ever figure it is usually the other fellow's job that is so fine ? It remains fine and perfect just as long as it is the other fellow's. The very minute he leaves it and we take it, it becomes our job and is no longer the other fellow's. Then it becomes a total loss, an undesirable thing, a situation nobody would want.

The good job is nearly always the other fellow's. Jobs have a habit of showing all their desirable points from the outside and their undesirable points from the inside.

The exterior view of a job is often attractive. The interior view is often unattractive. From the outside we see the salary but we do not feel the responsibility or the necessity for

work. On the inside the responsibility and the work have a habit of featuring themselves. We come into contact, there, with the necessity for making good. The bigger the salary, the more we feel that responsibility. If a man or a firm is giving us honest-to-goodness pay, if our envelopes each week contain important money, we are constantly aware of the necessity of giving value received.

All these things make jobs undesirable to the ones occupying them. The size of the pay envelope and the apparent lightness of the work make them very desirable to the person outside looking in. The fellow inside always has to look out.

The pilot of a river said to the engineer,

"You have a snap. All you have to do is to stay down there in the warm comfortable hold and keep a silly fire under the foolish boilers. Anybody could do that. No responsibility, no nothing, but just comfort and mechanical work."

"Comfort, your eye !" retorted the engineer. "It is often unbearably hot down here, always sooty, and I long for the fresh, outdoor air and the sight of the scenery. Snap ! You've got it yourself. Nothing to do but stand out there and watch the landmarks go by and twiddle a wheel-spoke now and then."

"Huh ! I wish you had the job awhile, and you'd see." "And I wish you had mine awhile, and you'd see," replied the engineer.

As a result of this argument and challenge these two men traded places. In a short time there came a confused jangling of bells from the bridge. There came also frantic calls from the engine room.

The man below called up. "Come down here ! I'm nearly smothered and I can't keep steam up high enough. Hurry down !" "I guess I will," said the man on the bridge. "I've run 'er aground."

Always wanting the other fellow's job. Always looking for a snap. Always discontented in the wrong way.

The sort of discontent that makes a fellow hustle so as to outgrow the job he has and fit into a bigger, comes under the poet's definition of "divine discontent." While that of the restless clock watcher and pay-roll hound, who is always dissatisfied with his job because he has to work between meals and who believes he knows of another job where he wouldn't, comes under a totally different head—that is diabolical discontent.

This world is not like a jar of ginger cookies—filled with snaps. It is a place where one must eat his bread in the sweat of his brow. There is not a finer seasoning or condiment or appetizer in the world than brow sweat. It can impart to some pretty poor grub the flavor of ambrosia.

Enthusiasm applied to any job can make it desirable. Energetic application to any task will do one of two things : Teach you to like the job itself, or teach some startled observer to like you well enough to give you a better one.

Seldom do you get a better or bigger job till you have overflowed the one you are in. Slopping over must not be taken for running over, either.

The position you occupy must be absolutely ramified with your personality. The job and you must be so interwoven, you and it must be so thoroughly identified with one another, that no one can think of the one without thinking of you. The job and you are one. If you drive a garbage wagon—a position as intrinsically honorable as that of president of a trust company—be so identified with the service this renders that when anybody thinks of that service they will think of you and think respectfully.

Be bigger than your job. The world is looking for people of that sort to take bigger jobs than yours. There is not a truer teaching in the Bible than that which assures us that "he who is faithful over a few things shall be made ruler over many." Remember that not one cent of the money in our pay envelopes would, if itemized, be labelled, "For hunting another job," or "for kicking about our present job." He who holds a job and draws pay for it and puts in any portion of the time he has sold to his employer in kicking about the duties of the place is getting at least some of his money under false pretenses.

The matter of the size of our pay check is discussable only when we are at first being engaged and at such subsequent intervals as we are ready to discuss the matter openly with our employer or employing firm. At all other times the matter is not according to Robert's Rules of order, "before the house," and nobody wants to hear you talk about it.

You may, indeed, get the consent of some other poor prune to listen awhile, but what is the reason and what is the penalty ? He is listening to you so you wont dare turn a deaf ear to him when he begins grumbling on his own account. He, too, has a tale of woe that he wants to sob out on somebody's shoulder. You having used his shoulder as a tear jug, he feels you are in duty bound—and he is right about it—to use yours for a similar purpose—an exchange of discourtesies.

Any job is respectable if occupied by a respectable person. Any job is honorable if occupied by an honest person. If the job is disgraceful, it has been made so by the character of the person occupying it.

Here is a little rule you will find it safe to follow—the well known Gillilan poem, entitled

"The Other Fellow's Job."

There's a craze among us mortals that
is mighty hard to name.
Wheresoe'er you find a human you
will find the case the same.
You may seek among the worst of
men and seek among the best,
And you'll find that every person is
precisely like the rest.
Each believes his real calling to be
along some other line
Than the one at which he's working—
take, for instance, yours and mine.
From the meanest "me—too" crea-
ture to the leader of the mob,
There's a universal hanker for the
other fellow's job.

There are millions of positions in the
busy world today,
Each a drudge to him who holds it,
but to him who doesn't, play.

Every farmer's heavy hearted that in
youth he missed his call,
While the same unhappy farmer is
the envy of us all.
Any task you care to mention seems
a vastly better lot
Than the one especial something that
you happen to have got
There is one sure way to smother
envy's heartache and a sob :
Keep too busy at your own to want
the other fellow's job.

—*Stone & Webster Journal*

The Relation of Science to Industry

By Robert Andrews Millikan, Director of the Norman Bridge Research Laboratory in Physics, Pasadena, California.

A WELL known public speaker of fifty years ago once remarked ruefuly after disastrous consequences had followed misplaced humor, "I rose by my gravity and fell by my levity."

I use this incident as an introduction to my speech on Science and Industry for the sake of calling attention to the fact that what is absurd or ridiculous to-day was perfectly good science, or at least good philosophy, not more than 350 years ago—that the very existence of the "laws of gravity" was discovered as late as 1650 A.D. and that "levity" and "levitation' have through all recorded history up to Newton been just as acceptable scientific ideas as gravity and gravitation—so recently have we begun to understand just a little about the nature of the world in which we live.

Nor do I need to go back 300 years to make my point as to the newness of our knowledge. It is within the memory of every man of sixty that in the great Empire State of New York the question could be seriously debated, and in the most intelligent of her communities, too, as to whether Archbishop Usher's chronology computed by adding Adam's 930 years to Enoch's 365 years to Methuselah's' 960 years, etc., gave the correct date of creation.

Importance of Correct Understanding

But what has this to do with "Science and Industry"? Everything. For mankind's fundamental beliefs about the nature of the world and his place in it are in the last analysis the great moving forces behind all his activities. Hence the enormous practical importance of correct understandings. It is his beliefs about the nature of his world that determine whether man in Africa spends his time and his energies in beating tom-toms to drive away the evil spirits, or in Phœnicia in building a great "burning fiery furnace" to Moloch into which to throw his children as sacrifices to his god, or in Attica in making war on his fellow Greeks because the Delphic Oracle or the flight of birds or the appearance of an animal's entrails bids him to do so,

or in medieval Europe in preparing for the millenium to the neglect of all his normal activities and duties as he did to the extent of bringing on a world disaster in the year 1000, or whether he spent his energies in burning heretics in Flanders or drowning witches in Salem, or in making perpetual motion machines in Philadelphia or magnetic belts in Los Angeles, or soothing syrups in New England.

The invention of the airplane and the radio are looked upon by everyone as wonderful and pre-eminently useful achievements and so they are—perhaps one-tenth as useful as some of the discoveries in pure science about which I wish to speak.

This new achievement of the race, this new capacity for education was after all only an inevitable incident in the forward sweep of pure science, which means simply knowledge, knowledge of the nature and capacities of the physical world, of the ethereal world (to which the radio belongs) of the biological world and the intellectual world; for this knowledge, as man acquires it, necessarily carries applied science in its wake.

What Made Airplane Possible

Look for a moment at the historic background out of which these modern marvels, as you call them, the airplane and the radio, have sprung. Neither of them would have been at all possible without 200 years of work in pure science before any bread and butter applications were dreamed of—work beginning in the sixteenth century with Copernicus and Kepler and Galileo whose discoveries for the first time began to cause mankind to glimpse a nature, or a god, whichever term you prefer, not of caprice and whim, as had been all the gods of the ancient world, but instead a god who rules through law, a nature which can be counted upon and hence is worth knowing and worth carefully studying. This discovery which began to be made about 1600 A.D., I call the supreme discovery of all the ages, for before any application was ever dreamed of, it began to change the whole philosophical and religious outlook of the race, it began to effect a spiritual and an intellectual, not a material revolution — the material revolution came later. This new knowledge was what began at that time to banish the monastic ideal which had led thousands, perhaps millions, of men, to withdraw themselves from useful lives. It was this new knowledge that began to inspire man to know his universe so as to be able to live in it more rationally.

As a result of that inspiration there followed 200 years of the pure science involved in the development of the mathematics and the celestial mechanics necessary merely to understand the movements of the heavenly bodies—useless knowledge to the unthinking, but all constituting an indispensable foundation for the development of the terrestrial mechanics and the industrial civilization which actually followed in the nineteenth century; for the very laws of force and motion essential to the design of all power machines of every sort were completely unknown to the ancient world, completely unknown up to Galileo's time.

Do you practical men fully realize that the airplane was only made possible by the development of the internal combustion engine, and that this in its turn was only made possible by the development of the laws governing all heat engines, the laws of thermo-dynamics, through the use for the hundred preceding years of the steam engine, and that this was only made possible by the preceding 200 years of work in celestial mechanics, that this was only made possible by the discovery by Galileo and by Newton of the laws of force and motion which have to be utilized in every one of the subsequent developments. That states the relationship of pure science to industry. The one is the child of the other. You may apply any blood test you wish and you will at once establish the relationship. Pure science begat modern industry.

In the case of the radio art, the commercial values of which now mount up to the billions of dollars, the parentage is still easier to trace. For if one's vision does not enable him to look back 300 years, even the shortest-sighted of men can scarcely fail to see back as much as eighteen years. For the whole structure of the radio art has been built since 1910 definitely and unquestionably upon researches carried on in the pure science laboratories for 20 years before anyone dreamed that there were immediate commercial applications of these electronic discharges in high vacuum.

The Same Story Everywhere

It is precisely the same story everywhere in all branches of human progress. I suspect it would be difficult to find one single exception. Here is the latest illustration that came to my attention recently in a letter from the Air Reduction Sales Company. It reads as follows: "We take pleasure in handing you herewith a complete set of luminescent tubes, each containing in the pure state one of the elements of the air, namely, nitrogen, oxygen, argon, hydrogen, neon, helium, krypton and xenon. It seems to us worthy of note that at the beginning of this century, these gaseous elements as such had practically no commercial value or significance. To-day the estimated value of the plants and equipment that have been created either to manufacture or to use and handle these gases in industry amounts to three hundred million dollars."

The writer of this letter might have added that the chain of discovery which led up to this result started in the most "useless" of all sciences, astronomy; for helium, as its name implies and as everybody knows was first discovered in the sun with the aid of the spectroscope, and thirty years later it was its discovery in minute amounts in our atmosphere, also with the aid of the spectroscope, that set us looking for the other inert gases of which the letter speaks and which have recently found such enormous application in neon tubes and the like.

But why continue this recital, for no intelligent man to-day needs to be convinced that our material prosperity rests wholly upon the development of our science. It is as to the broader values, intellectual and spiri tual, that even intelligent men sometimes express doubt. Let me then

start with the foundations that I have already laid and try to show to what these beginnings are leading, whither we are going, not materially, but as feeling, thinking and willing beings.

The Soul of Prosperity

Was Pasteur only a scientific enthusiast when he wrote "In our century science is the soul of the prosperity of nations and the living source of all progress. Undoubtedly the tiring discussions of politics seem to be our guide—empty appearances! What really leads us forward is a few scientific discoveries and their application.

Or was H. G. Wells, himself not a scientist at all, merely talking nonsense when he wrote quite recently (and note that he is not talking about a material thing either):

"When the intellectual history of this time comes to be written, nothing I think, will stand out more strikingly than the empty gulf in quality between the superb and richly fruitful scientific investigations that are going on, and the general thought of other educated sections of the community. I do not mean that scientific men are as a whole, a class of supermen, dealing and thinking about everything in a way altogether better than the common run of humanity, but in their field they think and work with an intensity, integrity, breadth, a boldness, patience, thoroughness, fruitfulness, excepting only a few artists which puts their work out of all comparison with any other human activity. In these particular directions the human mind has achieved a new and higher quality of attitude and gesture, a veracity, a self-detachment, and self-abrogating vigor of criticism that tends to spread out and must ultimately spread to every other human affair."

Man Looks Around

We have learned within the past half dozen years through studies in radio activity that this world of ours has in all probability been a going concern, in something like its present geological aspects as to crustal constituents, temperatures, etc., for more than a billion years, and hence that the human race can probably count on occupying it for a very long time to come say another billion years; and further that mankind has been doing business on it in something like his present shape for something like 20,000 years, or possibly 50,000, but in any case a time that is negligibly small in comparison with the time that is behind and the time that is presumably ahead of him—in other words, we have learned that mankind speaking of him as an individual human being, is now just an infant a few months old at the most, an infant that up to about one minute ago, for the 300 years since Galileo is but a minute in the geological time-scale, has been lying in his crib spending his waking hours playing with his fingers, wiggling his toes, shaking his rattle, in simply becoming conscious of his own sensations and his functions, waking up, as he did amazingly in Greece, to his own mental and emotional insides. Just one minute ago he began for the first time to peer out through the slats in his crib, to wonder and to begin to try to find out what kind of an external world it is that lies around him, what kind of a

world it is in which he has got to live for the next billion years. The answers to that question, even though never completely given, are henceforth his one supreme concern.

In this minute of experience that he has already had he has tumbled down in his crib, bumped his head against the slats, and seen stars—real ones and unreal ones, and he hasn't yet learned to distinguish with certainty between those that actually exist and those that only seem to exist because his eye-balls have been subjected to the pressure that comes from a blow, and so he is reaching out his hands part of the time trying to grasp illusions, and yet slowly, painfully learning, bit by bit, that there is an external world physical and biological, that can be known, that can be counted upon, when it has once become known, to act consistently, not capriciously, that there is a law of gravity and that it isn't necessary to be covered with bruises all the time because he forgets that it exists, that there is a principle of conservation of energy, and that all constructive and worth-while effort everywhere must henceforth take it into account and be consonant with it, that it is not worth while to spend much time hereafter with sentimentalists who wish that that law did not exist and sometimes try to legislate it out of existence, that again there are facts of heredity that it is utterly futile to inveigh against, that our whole duty is rather to bend every energy to know what they are and then to find how to best live in conformity with them, that in a single sentence there is the possibility ahead of mankind of learning, in the next billion years of its existence to live at least a million times more wisely than we now live. This is what Pasteur meant when he said "What really leads us forward is a few scientific discoveries and their applications." This is what Wells meant when he contrasted the result of the objective method of learning used in the pursuit of science with what he calls "the general thought of other educated sections of the community." The one guesses and acts upon its hunches or its prejudices, the other tries at least to know, and succeeds in knowing part of the time.

We Need Science in Education

We need science in education and much more of it than we now have, not primarily to train technicians for the industries which demand them, though that may be important, but much more to give everybody a little glimpse of the scientific mode of approach to life's problems, to give everyone some familiarity with at least one field in which the distinction between correct and incorrect or right or wrong is not always blurred and uncertain, to let him see that it is not true that "one opinion is as good as another," to let everyone understand that up to Galileo's time it was reputable science to talk about gravity and levity, but that after Galileo's time the use of levity became limited to the ridiculous, that "the town that voted the earth was flat, flat as my hat, flatter than that," had a perfect right to exist before 1400 A.D., but not after that date, that we are learning slowly through the accumulated experience and experimenting of the centuries, especially since 1600 A.D., more about the eternal laws

that do govern in the world in which we live. And for my own part I do not believe for a moment that these eternal laws are limited to the physical world either. Less than sixty years ago, to take one single illustration, there existed a relatively large political party in the United States called the Greenback Party which jumped at conclusions and which conducted campaigns to induce our government to go over to a flat money basis. I do not suppose such a party could exist to-day unless it be in states that pass anti-evolution laws, for there are some laws that have become established, even in the field of finance.

Knowledge Makes Us What We Are

This brings me to a brief discussion of the current opposition to the advance of science—an opposition participated in even by some intelligent people, on the ground that mankind cannot be trusted with too much knowledge, by others on the ground that beauty and art and high emotion are incompatible with science. Now, fear of knowledge is as old as the Garden of Eden and as recent as Dr. Faust, and there is no new answer to be made to it. The old answer is merely to point to what the increase in knowledge has done to the lot of mankind in the past, and I think that answer is sufficient, for it has certainly enfranchised the slave and given every man, even the poorest such opportunities as not even the prince of old enjoyed. Who would go back to the stone age because stone age man had no explosives. Of course every new capacity for beauty and joy brings with it the possibility of misuse and hence a new capacity for sorrow. But it is our knowledge alone that makes us men instead of lizards, and thank God, we cannot go back whether we would or no. Our supreme, our god-like task, is to create greater beauty and fuller joy with every increased power rather than to turn our weeping eyes toward the past and fling ourselves madly, unreasoningly athwart the path of progress.

No, the only real question in a nation like ours is not whether science is good for us materially, intellectually, esthetically, artistically. Of course it is, for science is simply knowledge and all knowledge helps. The only real question is how the forward march of pure science and of applied science which necessarily follows upon the heels, can best be maintained and stimulated for, as Pasteur said, "It is this alone that really leads us forward."

Whose Job to Support Science?

The answer to that question will depend upon the nature of one's whole social philosophy. If you think that social progress is best brought about by a paternalistic regime of some kind, by throwing upon a few elected or hereditary officials the whole responsibility for social initiative of all sorts, then you will say, "Let the government do it all; let it establish state universities and state research laboratories and state experimental projects of all kinds as it has done in most European countries and let the whole responsibility for our scientific progress lie in these institutions." But if you believe with the early makers of our nation in the widest

possible distribution of social responsibility, in the wide-spread stimulation of constructive effort, in the nearest possible approach to equality of opportunity, not only for rising to wealth and position, but for sharing in community service, then your industries which are themselves the offspring of pure science, will join in the great nation-wide movement to keep alive the spirit of science all over this land of ours through keeping pure science going strong in the universities, its logical home, and applied science going strong in the private industrial laboratories where it thrives best.

—*N.E.L.A. Bulletin*

New Values in Industry

By Charles M. Schwab, Chairman of the Board, Bethlehem Steel Corporation

(Article No. 1 of the "Universal Safety Series," presented by the National Broadcasting Company in conjunction with the National Safety Council.)

IN my career of nearly fifty years in business and industry, I have participated with real personal satisfaction in the unfolding of a great human relationship between those who manage and those who labor. Whatever else I may have achieved, my part in this endeavor will remain my most cherished possession.

During no other era have labor relations been so sound and wholesome as in America to-day. No people in the world are as free from class feeling. Here the worker of today is the manager of tomorrow. Our industries prosper because men are doing their jobs better. They realize that they profit as their company prospers.

Management recognizes that our economic system must enable men to live on an increasingly higher plane. It must enable them to fulfill their desires and satisfy their reasonable wants and give them that feeling of security which is essential to happiness and efficiency.

What are these reasonable wants which men have a right to see satisfied as far as the conditions of industry permit ? Out of my long experience in industry I have come to the conclusion that they include :

Fair wages for efficient service.
Steady, uninterrupted employment.
Safeguarding of lives and health.
Good physical working conditions.
A voice in the regulation of conditions under which men work.
Provision for laying up savings and to become partners in the business.
Some guarantee of financial independence in old age.

With fair wages, steady employment, a financial interest in the business, and a means of contact and co-operation with the management through representatives of his own choosing, the worker has secured the

fulfillment of the most important and vital of his desires.

But there are other factors which should not be overlooked. One of these concerns the safety of work, for, indeed, accidents affect both wages and stability of employment.

Noteworthy advances have been made in industrial safety since the beginning of the century. They reflect credit alike upon management and men, for essentially it has been a co-operative movement. Accident prevention is a joint responsibility upon employees as well as employers. It requires activity on the part of both and the enthusiastic interest of all.

I have always said that no matter how great or how small his position, a man can do better work under the spur of encouragement than under the lash of criticism. It is this spirit of encouragement which has brought the safety movement in this country to its present high state of efficiency.

Then, too, that splendid organization the National Safety Council, has extended its field of activities since it was organized a few years ago until today it reaches out into every industry and literally every home in America. It has done commendable work and it is going still further in unfurling the banner of universal safety to all the civilized nations of the world.

The problem of safety is not new. As a matter of fact, it is as old as civilization. The first law of nature is self-preservation, but, like all of the wonderful advances in human endeavour, it required the vision and faith of far-seeing men to make the safety of workers an essential feature of good management in our industries.

What is safety work ! The best definition I have heard was given by the Rev. John McDowell. He stood before the steel men in convention assembled, with an empty sleeve that bore mute evidence of his early years as a Pennsylvania miner. He talked with authority, but best of all he talked from his heart. Let me quote him :

> To save human life is the noblest of all purposes. It embodies the highest ideal of humanity. It connserves the best asset of the nation ; provides its best protection, and creates its real glory. It incarnates the spirit of democracy and brotherhood.

That this spirit has taken hold of industry is evidenced by the wonderful achievements that have been accomplished with the co-operation of employees in eliminating needless accidents and thus adding to the happiness of homes throughout the land.

I have gone through some rather dark chapters in American industrial history. It is a great joy to realize that humanity rules today ; that industry has awakened to the fact the employer in engaging men's services is entitled to use them, but not to abuse them, and that the rights of employees include the right to work safely and the right to live in such a way that they and their families all have their full measure of security, health and happiness.

I dare say that the safety movement as an essential feature of good relations has so embedded itself in industry today that no backward

step can ever be taken. Workers collectively and individually are more cognizant of safety in their daily occupations. Furthermore, they have come to realize the economic importance to themselves, to their families and to their companies in avoiding accidents.

It is a source of real satisfaction to me that the steel industry has played an important part in pioneering this, both as a great humanitarian and a great economic movement. And let me say here that it does not detract in any way from the broad humanitarian aspects of this work to consider its economic aspects in sustained purchasing power, in providing steady employment and in keeping the wheels of industry moving. Indeed, we have a new measure of appraisal of its worth, for under present-day economic conditions in America, workers are more than producers; they constitute the very backbone of our large scale consumption.

In my own company, the Bethlehem Steel Corporation (and this is typical of most companies) progress in accident prevention during the past few years has resulted not only in a greater saving of life and limb but also in a saving to employees in wages alone of millions of dollars. For this accomplishment I give credit to that fine, stalwart body of co-workers who have helped build our company.

What has been accomplished in the conservation of human life in industry is the direct result of the policies of forward-looking management and far-sighted workers. It is highly fitting that we in America should have developed this new leadership. It is quite in keeping with our democratic ideals of sharing opportunity and responsibility, but, best of all, it brings a greater measure of happiness into the homes of our land.

The highest degree of actual service in America today is not necessarily rendered by those who are strongest socially or economically. Indeed, I believe the working men and women of our country, by their industry, their thrift and their good common sense are the real bulwarks of our institutions. The capacity for Americans to progress is due not so much to economic advantages as to a great degree of good will in their relations with each other. When we bring ourselves to believing that those with whom we deal have motives no less admirable than our own we have laid the foundation for real co-operation. Management has come to know that, on the whole, labor meets good will with good will, respect with respect. American workers want good leadership, and it has been my observation that their response to it is genuine and hearty.

Even after so many years of active business life I still find my greatest joy in work. Real happiness lies in doing the day's work with a zest and good will free from worry and anxiety, under the spur of encouragement and the reward of achievement.

Let us hope that the new order in industry will hasten the day when we shall cease to talk about a separation between labor and capital and begin to think of ourselves as contributing to a co-operative undertaking, in the advancement of which every supervisor and every employee is an essential factor. We will continue to

co-operate with each other in promoting good working and safety conditions, that we may have a nation of contented, self-respecting citizens and a prosperous and progressive industry in the interest of society at large.

And so we find better industrial relations and safety working hand in hand—growing in usefulness, developing each day in a broader service. It is truly a pleasant picture but there is still much that can be done.

It is my sincere wish—and hope—that the day will come in the not far distant future—when the protecting arms of Universal Safety will spread out over all industry and reach directly the millions of workers who make industry possible.

—*National Safety News.*

Lighting Hens in Winter

By J. E. Dougherty, Associate Professor of Poultry Husbandry, University of California.

DOES it pay to use artificial lighting in the laying house in Winter? Mathews in his book on the use of electricity in agriculture in England says, "The use of electric light to increase egg production during the winter months has proved to be one of the most important commercial innovations introduced into the poultry world during recent years. It has now long passed the experimental stage and is taking its place as one of the necessary installations on the modern poultry farm. Unfortunately there are a number of poultry farmers who, after placing lights indiscriminately in the laying pens, and further, using them irregularly fail to obtain the desired results, and then raise their voices against the practice. Investigation of cases similar to these showed that the cause of the trouble was due to too little attention being paid to the types of reflectors used, the incorrect arrangement of the lights and erratic time-keeping. The intensity of the light on the floor is a determining factor in the amount of activity shown by the birds during the lighted periods, and there is a certain intensity of light below which the activity of the birds decreases.

Fairbanks states that the use of artificial light to supplement daylight and make a longer working day for the layers, thereby stimulating egg production during the winter months, has been proved conclusively to be practical and profitable. He states further that under normal daylight conditions the intensity of the light up to a certain point determines the speed with which birds can pick up grain or eat mash. Therefore it is reasonable to assume that when artificial light falls below a certain intensity there is a decrease in the activity of the birds and in the amount of feed eaten. In his investigations, Fairbanks found that there must be not only an effective illumination of the floor and feed hoppers but also some direct light on the perches to obtain maximum activity

of the birds, increased feed consumption and more eggs.

The New Jersey Agricultural Experiment Station placed two pens of 100 hens each under exactly similar conditions except that one pen was lighted each morning from Nov. 1 to April 1. In this period the lighted pen produced 6,992 eggs and the unlighted pen 5,595 eggs.

At the Pennsylvania Agricultural Experiment Station pullets given morning light from Nov. 1 to March 1 laid 17.1 eggs more per bird in this period than similar pens of pullets receiving no artifiicial light.

The California Agricultural Experiment Station says, "It has been assumed that (*a*) a laying hen does not need any more sleep and rest in winter than in summer to keep in good health ; (*b*) the only reason for her spending a longer time on the roosts in winter is because there are more hours of darkness. Experiments and practical experience seem to prove quite conclusively the soundness of these assumptions. Lighting simply exerts a stimulus on production by lengthening the working day so that the hen can eat and exercise more. It does not over-stimulate or force in the sense that a drug does. It is, therefore, not injurious to either pullets or hens and there should be no ill effects."

The capacity of a hen's crop being limited, she cannot, during the short days of winter, fill her crop before going to roost with much more than enough food to nourish her body during the long hours of darkness. Very little is left to be manufactured into eggs. The result is less eggs in winter than at other seasons of the year.

Hens begin to respond to artificial lighting in a week or ten days and the maximum response is obtained in about three weeks. Production then continues at high level well into March when a slump usually occurs which lasts for some weeks and is accompanied by a partial molt. It is evident, therefore, that increased production in winter is usually obtained at the expense of spring production and the annual lay is not necessarily increased. The value of artificial lighting depends on obtaining more eggs in winter when prices are high at the expense of less eggs in spring when prices are low. If it does this it pays by increasing the average price per dozen for the year.

The operating cost for electric lighting is negligible. The author found by foot-candle-meter test that one 100-watt inside frosted lamp with an efficient reflector would amply light an area (including roosts) 20 ft. square. This area provides enough floor space for 200 leghorns. With an average period of two hours of electric light per day for the winter season, such lighting would cost 12 cents per month per 100-watt lamp at 2 cents per kw-hr., or 6 cents per 100 hens per month. Broken lamps plus interest and depreciation on the installation for the entire year might double this expense. But even at 12 cents per 100 hens per month for a four-month lighted period, or 48 cents per 100 hens per year, an increase of only 24 eggs per 100 hens for the winter season would be needed to pay all costs, assuming increased winter production balances decreased spring production

and winter eggs bring 2 cents each more than spring eggs.

An average increase in winter lay of only 10 per cent. would amount to ten eggs per 100 hens per day, or 300 per month, or 1200 for four months. So 1,200 less 48, or 1,152, would represent increased returns in terms of eggs, and 1,152 multiplied by 2 cents, or $23.04, would be the increased returns per 100 hens greater money value of these eggs over spring eggs. The increase in lay obtained will depend on how effectively the house is lighted and on how much more feed the hens eat due to the lights. Unless the lights bring about the consumption of more pounds of a correctly formulated ration, an increase in production cannot be expected.—

—*Electrical West.*

H. B. Chant, Clinton

Herman Benson Chant

Clinton lost a good citizen when, early Monday morning, June 17th, after an illness covering several months, Herman Benson Chant passed away at his home, Rattenbury Street, East.

Mr. Chant was born in York County, but came to Clinton when a young man, well on to fifty years ago, and this has been his home ever since. He was for many years with the Doherty Organ and Piano Co., during the latter years of his stay being in charge of the electrical and steam engineering plant and superintendent of the factory. About this time, too, he was elected a member of the town Waterworks Commission, and in 1913 when Clinton bought out the Clinton Electric Light Co., Mr. Chant was given the management of both the electrical and waterworks department. Later when Hydro was installed and the waterworks and electrical departments were placed under the management of a Public Utilities Commission, Mr. Chant was appointed superintendent and treasurer, with full charge of the office and the outside work. Mr. Chant was possessed of an analytical mind and he was always studying, always learning, so that he mastered his work and was considered an expert in his line.

Mr. Chant was public-spirited and was always interested in anything for the general good. He served as a member of the Public school board for years, later on the Collegiate board, of which he was a member to the last. He was secretary of the local Masonic lodge and treasurer of the Oddfellows lodge and for a great many years had been an official of

the Wesley, later the Wesley-Willis church.

Mr. Chant is survived by his wife, who was formerly Miss Charlotte Holmes, and one son and two daughters: Fred Chant of Pittsfield, Mass., Mary, Mrs. W. E. Floody, Toronto, and Gertrude, Mrs. J. A. Sutter, Clinton. His aged mother, Mrs. C. H. Chant, resides at Unionville, and there are two brothers, J. H. Chant, Unionville, and Prof. C. A. Chant of Toronto University, and two sisters: Mrs. D. D. Ross of Rorketown, Sask., and Mrs. F. A. Jamieson, Toronto.

James Hyslop, Toronto

In the death of James Hyslop, 341 Armadale Avenue, Toronto, in the General Hospital on Wednesday, June 19, the Hydro-Electric Power Commission of Ontario lost one of its most popular mechanical engineers. Mr. Hyslop, who was in his 60th year, had joined the staff of the commission in 1922 as assistant station engineer, attached to the building section of the electrical department on sub-station design, more particularly on outdoor structures. He held this position at the time of his death.

Mr. Hyslop was born May 24, 1870, at the farm of Gerranton, parish of Crossmichael, Kirkcudbrightshire, Scotland, and he received his early education at Clarebrand public school and Castle Douglas academy.

In 1883 his family moved from Gerranton (which they had farmed since 1768) to the farm of Gateside in the parish of Lochrutton, Kirkcudbright, where he entered Dumfries Academy.

He entered the Dumfries iron works as an apprentice machinist in 1885, and at the same time he began the study of electricity, mathematics and mechanical drawing, successfully writing the South Kensington science and art examinations. This was followed by electrical and mechanical engineering courses at Herriott Watt Technical College, Edinburgh, which he began upon leaving the iron works in 1890.

In 1892 Mr. Hyslop migrated to the United States and settled in Chicago. In the same year at Hastings, Neb., he was married to Margaret F. Forsythe.

In May, 1895, he entered the employ of the Whiting Foundry Equipment Company as a draftsman, and advanced to the position of chief draftsman and designing engineer on cranes and foundry equipment. Owing to ill-health from climatic conditions, he resigned in Feb., 1911, and moved to Winnipeg, where he became operating engineer of the Greater Winnipeg Water district, where he remained until he came to Toronto in 1922.

Howard Chester, Coldwater

Mr. Howard Chester, publisher of the Coldwater *Planet*, Clerk and Treasurer of the Village of Coldwater, and Secretary of the local Hydro from the beginning of service, passed away early in May after a long period of ill health during which he carried on his many duties with remarkable fortitude and courage. He was a staunch Hydro enthusiast, and will be missed by a large number of Hydro friends.

His son, H. M. Chester, has been appointed in his place.

HYDRO NEWS ITEMS

Central Ontario System

On May 31st the Peterboro Gas Plant was taken over by the municipality of Peterboro and is now being operated by the Peterboro Utilities Commission.

* * * *

The Municipality of Oshawa voted on the purchase of their distribution system and gas plant on June 15th, and the result was 865 for and 165 against. The election of a Public Utilities Commission was favored by a vote of 1028 for the by-law and 150 against.

* * * *

Construction of approximately 1/5 mile of rural line is now being built to serve four consumers in the Townships of Rawdon and Seymour, Campbellford, R.P.D.

* * * *

Construction of approximately 20 miles of line to serve 58 consumers in the townships of Sidney and Thurlow, Belleville, R.P.D., is now underway.

* * * *

Commission approval has been given for the construction of a new 750 kv-a., 6600/2200 volt transformer station at Trenton, with provision for a second transformer of the same size, the station to be equipped with automatic, reclosing, feeder breakers.

Georgian Bay System

The new development at Trethewey Falls on the Muskoka River is progressing favorably, and the plant will probably be placed in operation by the end of the present summer, thus assuring an additional 2,300 h.p. for the Georgian Bay System. The generating plant is to be semi-automatic, and will be operated from the switchboard of the main Muskoka development.

* * * *

The 38,000-volt transmission tie line between the Muskoka and Wasdells divisions of the Georgian Bay System has been completed and placed in operation, and is now working satisfactorily. By this means the Wasdells Division is assured of a reliable source of power, independent of the Wasdells Development itself.

* * * *

Arrangements have been completed for restringing the steel conductor on the Wasdells Division transmission line between Cannington and Greenbank sub-stations with No. 0 aluminum conductor. Arrangements have also been made to replace the 4,000 volt line between Greenbank substation and the municipalities of Uxbridge and Port Perry with a 22,000 volt line, utilizing the present conductor for that purpose. The change involves abandoning the

Greenbank sub-station and salvaging the equipment, as well as the construction of two new 300 kv-a. stations, one at Uxbridge and the other at Port Perry so as to serve each municipality at 22,000 volts from a separate station. A new rural feeder will also be constructed from the new Uxbridge station to Greenbank to take care of the rural load at the latter location. This work will be undertaken at once and will be completed before the end of the present summer.

* * * *

The Commission has completed the purchase of the generating plants, transmission lines, and distribution systems of the Bala Electric Light Co., serving the municipalities of Bala, Port Carling and MacTier, as well as the adjacent summer resort district. Arrangements are being made to install meters at the premises of all consumers, and to make whatever changes may be necessary to bring all of the equipment and lines up to the Hydro standard of construction, so as to assure all customers of receiving the best possible service.

* * * *

The three 40 kv-a. transformers at the Coldwater sub-station have been replaced with three 100 kv-a. units to provide for the increased demand for power at the Stone Quarry.

* * * *

The Commission has just completed an installation of Oranamental Street Lighting for the Town of Gravenhurst consisting of the erection of sixteen ornamental standards equipped with 300 watt multiple lamps fed from an underground system. This improved street lighting has been installed on the main street and all poles and overhead wires have been removed, including those of the Bell Telephone Company, which has resulted in a most pleasing appearance through the main business section of the Town.

* * * *

The three 50 kv-a. units at the Holyrood sub-station, which serves the municipalities of Lucknow and Ripley, have been replaced with a 300 kv-a. three-phase unit formerly at Meaford.

* * * *

The 300 kv-a. 3-phase transformer at the Meaford substation has been replaced with three 250 kv-a. single phase units.

* * * *

The Commission is assisting the local Commission of Orangeville in connection with the installation of an ornamental street lighting system on the main street. It is expected that specifications will be prepared and tenders called for covering this work in the very near future.

* * * *

Extensions in the following rural power districts have been arranged for or under construction at the present time : five and a half miles of line in Innisfil Rural Power District which serves the west side of Lake Simcoe; three miles of line in the Sparrow Lake Rural Power District which serves the summer resort area in that district, and one mile of line in the Beaumaris Rural Power District which serves a large portion of the Muskoka District. These extensions are largely due to the increased demands for electrical energy in the summer resort districts. The

construction of six and a half miles of line on Scugog Island and one mile of line to serve the hamlet of Manchester all of which is located in the Port Perry Rural Power District has just been completed and placed in service.

* * * *

During the past few months, the old Severn System has lost by death, three secretaries who have been prominently connected with the local systems since the inauguration of service; Mr. T. W. Brown, known to his many friends as "Tim", late Clerk of Tay Township and in charge of the accounts of the Waubaushene Hydro, Mr. C. S. Burton, who occupied a similar position in the Village of Elmvale, and Mr. Howard Chester of Coldwater, whose recent death is recorded elsewhere in this number.

These men were all prominent among the Severn System "Old Boys" when the going was not as comfortable as it is now, and will be missed by all who come in contact with the local offices.

* * * *

Niagara System

In order to carry the increased load in Port Colborne and vicinity the Commission is constructing a new steel tower transmission line from Welland to Port Colborne, a distance of 6¼ miles. This line will operate at 46,000 volts and will be completed and in service by the end of June.

* * * *

There is considerable activity in the construction of rural lines in the townships north of Toronto, where 17.6 miles are being built to serve 54 farms, a summer cottage area and a summer camp. Also in the Beamsville R.P.D., 8 miles are being built to serve 30 farms a large portion of which is back of the escarpment where development up to the present time has been slow.

* * * *

An office has been established in Sutton for the operation of the Keswick R.P.D. with Mr. C. L. Pearson as Superintendent. This district was formerly operated from the Bond Lake R.P.D. office in Richmond Hill.

* * * *

One of the Natural Gas companies in Sandwich East Township is installing a 450 kv-a., 26,400/575 volt step-down station approximately 1½ miles West of the Commission's Essex transformer station to take power in connection with the gas plant. The installation of this station is being taken care of by the Commission's engineering staff on behalf of the Company.

* * * *

During the last two weeks of May and the first week of June work orders were issued for over 95 miles of rural extensions in the various rural power districts served from the Niagara system. The service from these extensions will add approximately 270 consumers to our lines.

* * * *

A second bank of 3—2,500 kv-a. transformers is being installed at Guelph transformer station. All 13 kv. switching is being replaced by new outdoor equipment and the existing 13 kv. switch-room is being converted into a control-room.

A new 13 kv., line from Hamilton transformer station to Canada Crushed Stone and a substation near Vinemount went into operation at the beginning of this month.

* * * *

The transformer capacity of Port Colborne distributing station is being increased by the addition of one 1,500 kv-a., 3-phase unit and additional switching equipment, emergency bus, etc., is being installed.

* * * *

Work has commenced on the purchase and erection of equipment, buildings and structures required at the Toronto-Leaside transformer station to receive additional power under the 260,000 horsepower contract. This covers 15,000 kv-a. transformers, 15,000 kv-a., synchronous condensers, load dispatcher's board and the necessary 220/110-13 kv. switching apparatus to complete the station.

* * * *

Rideau System

Instructions have been issued for the erection of a 100 kv-a., 44 kv., single-phase, out-door substation to be known as Forfar distributing station. This will be located between Philipsville and Forfar, where the road is crossed by Smiths Falls-Kingston line from which the power will be taken.

Thunder Bay System

Due to the increasing demand for power at Port Arthur and Fort William in general, and at the Great Lakes Paper Mill in particular, the Commission has decided to complete the Alexander Development and construction work is now progressing. An effort will be made to have two units in operation under partial head by the Fall of 1930, with the entire plant completed for three units under full head by the end of 1931.

* * * *

The present relay equipment is being removed and a ground selector system with balanced current potential relay protection is being installed in Port Arthur transformer station on the 22 kv., circuits : this being done to obtain faster clearance of faults.

Mr. E. B. Brown, Clerk of the Village of Victoria Harbor and Secretary of the local Hydro System broke his ankle some weeks ago when he stepped off the edge of the sidewalk. He is again at his office but will use a cane for some time.

* * * *

Mr. W. R. Parker, Secretary of the Penetanguishene Water and Light Commission, has been in the Private Patients' Pavilion of the Toronto General Hospital for some weeks. His many friends join in best wishes for his early recovery and return to his desk.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

The Lightning Problem in Power Transmission and Distribution

By H. M. Towne, Lightning Arrester Engineering Dept., General Electric Company, Pittsfield Mass.

(*Read before Association of Municipal Electrical Utilities, at Bigwin Inn, Lake-of-Bays, Muskoka, July 4th, 1929.*)

AMAZING advances in development, transmission and distribution of electric power make the problem of lightning protection increasingly vital. The increasing geographical exposures of electric systems and their interconnections, tremendous increases in size and cost of apparatus, and the continually growing critical attitude of power consumers towards interruptions in any electric services are factors which are making this subject immense in economic importance. It is the purpose of this paper to review the fundamental principles underlying the lightning problem and to discuss the lightning arrester and factors affecting its performance and application and other protective measures conducive to reliability and economy.

Electrostatic Induction

During lightning storms potential gradients as high as 100 kv. per foot may exist in the air dielectric between cloud and earth just prior to a lightning flash. The gradient depends upon the magnitude of charge on the cloud and the elevation of the cloud above earth. The gradients are highest in the region directly under the charged cloud and decrease quite rapidly as the outlying regions are reached. The gradient at any point not under the cloud will vary approximately inversely as the cube of the distance from that point to the cloud. Thus, when the distance from the cloud to an outlying point is doubled, the gradient is one-eighth and when the distance is tripled the gradient is one-twenty-seventh. It

CONTENTS

Vol. XVI **No. 7**

July, 1929

	Page
The Lightning Problem in Power Transmission and Distribution	221
Factors Governing the Design of 115-230 Volt Distribution at High Load Densities - - -	247
Modern Billing Methods - - -	257
A.M.E.U. Report - - - - -	267

therefore follows that the most serious induced voltages may occur on the part of circuits in the region directly beneath the charged cloud, or more specifically, beneath the portion of the cloud having the highest charge to earth.

The presence of a charged cloud over the electric circuit causes a separation of charges at the earth's surface. If the cloud is negatively charged with respect to earth, positive charges will be attracted and accumulate on the elevated conductors and the negatives repelled from the conductors to earth. Since the line conductors are not perfectly insulated from earth the comparatively slow passage of the cloud over the line will give the normal negative charges on the conductor time to travel to earth either through leakage resistance of insulators or through neutral connections, or into parts of the circuit remote from the charged cloud. If the cloud is assumed to discharge in zero time, the disappearance of the cloud field will cause a potential to simultaneously occur on the conductor, the space distribution of the potential conforming to the distribution of the cloud field before discharging. The potential induced will be the product of the potential gradient between cloud and earth before cloud discharge occurred and the height of the conductors above earth. Obviously, the cloud cannot actually be discharged in zero time and so the induced voltage on the conductor will be somewhat less than the gradient times the height. This is because during the time the cloud is discharging some spreading out of the induced voltage occurs with attending current flow, by which action some of the electrostatic energy has become electromagnetic energy.

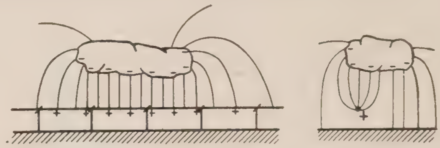


Fig. 1

Fig. 1 may serve to illustrate the bound charge on the line conductor just prior to the cloud discharge. During this state of affairs the line conductor and earth are still substantially at the same potential. This is explained by the existence of two fields in opposite directions, that is, while the main field is from positive earth to negative cloud, there is a counter-field from the accumulated positives on the line to the repelled negatives in the earth. These two fields attain somewhat of a balance since a more intensive cloud field creates a more intensive separation and resultant counter-field.

The release of the bound charge on the line coincident with the lightning flash to earth is illustrated in Fig. 2.

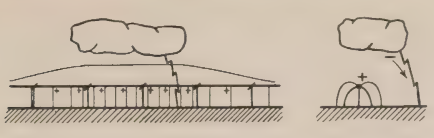


Fig. 2

While a more or less uniform cloud field is represented, it is probable that such a simple condition very seldom exists. Varying configurations of the cloud and varying degrees of charge within the cloud or between it and other clouds complicate the field distribution and resultant separations of charges at the earth's surface. Therefore, when the cloud discharges and the main field collapses, the attending release of the bound charge gives rise to a transient potential which may be of unequal magnitude at different points along the line conductor. Furthermore, the cloud may not discharge completely, but the potential induced will depend on the change from the initial gradient between cloud and earth and will be proportional to the reduction in the cloud charge by the lightning flash. If a lightning flash does not occur and the charged cloud simply drifts over and away from the line conductors, the bound charge is released with corresponding slowness of the removal of the cloud field, and no potential difference will occur between line conductor and earth. While the cloud has been assumed to be negative, this may equally well be positive in nature. The induced charge on the line resulting from release of a bound charge will be of opposite sign to the charge on the cloud. Surge recorder studies do not seem to show any decided predominance of positive or negative induced voltages on lines. The induced voltage is unidirectional in some cases and frequently oscillatory. The oscillatory surges obtained in surge recorder investigations seem to have varying degrees of damping of the oscillations and the oscillations may be attributed to flashovers on the line and not necessarily indicating that the lightning flash and decay of the cloud field was oscillatory.

A voltage might be induced on the line conductors having the same polarity as the cloud charge. This might come about when a cloud having no potential to earth is very suddenly charged up by a lightning flash from another distant cloud. Under such condition the line conductor acts much as though it were perfectly insulated from earth. The cloud to earth field is created so quickly that separation of charges by leakage through insulation resistance cannot result, and the only separation of charges is between the top and bottom of the conductor. The induced potential on the line will be the product of the instantaneous voltage gradient and the line height as before, but the induced voltage having the polarity of the suddenly charged cloud.

The lightning voltages so induced on electric circuits may be of any magnitude up to the flashover of the insulation. However, the worst condition probably exists quite infrequently and surge investigations[1] on three high voltage systems during 1927 and 1928 evidenced potential gradients up to 54 kv. per foot. These are obtained by dividing the recorded voltage by the height of

the conductor above earth and it is probable that the recorders were not always located to record the highest gradient. Furthermore, the gradient may often be altered by trees, buildings and general topographic conditions which may afford some shielding to the line. However, with a gradient of 50 kv. per foot the voltage induced on a line 40 feet high might be of the order of 2,000,000 volts. Considering the maximum possible gradient of about 100 kv. per foot, a line 40 feet high would have to be insulated for 4,000,000 volts impulse flashover to withstand the worst condition.

The lightning flashover limit is fairly definite for those lines with steel towers or grounded hardware and less definite for the case of wood poles and cross arms in series with the line insulation. Wood greatly increases the lightning flashover of a line and this increase is about the same for dry, wet, creosoted or untreated poles or cross arms. F. W. Peek, Jr., has given a figure of 180 kv. per foot[2] for wood flashover. This may seemingly conflict with the maximum gradient of 100 kv. per foot previously mentioned, but the difference is reconciled by the fact that the maximum cloud-to-earth gradient of 100 kv. per foot is based on a steady state condition simulating a direct current charge on the cloud, while the wood flashover is for very brief voltage applications.

Since the lightning conditions vary in different localities and at different seasons, the practice in insulating lines naturally varies in accordance with the geographical locations of the lines and the experience of the operating engineers. However, those lines of 66 kv. and above which usually have steel towers are generally insulated so that the r.m.s. 60 cycle dry flashover averages about 3.8 times the system rating or 6.5 times the system line-to-neutral voltage. The lightning flashover of the insulation based on a fairly steep wave will approximate 10 to 12 times the crest value of the line-to-neutral voltage of the system. For those systems with wood poles and ungrounded hardware the lightning voltages from line-to-ground will not be limited to 10 or 12 times normal but may rise to very much higher values. Owing to the fact that distribution circuits frequently have the same elevation above ground as the much higher voltage transmission lines, the former may frequently have lightning voltages approaching those on the latter, particularly if they have wood poles and cross arms. Therefore, when expressed in terms of times normal, the low or medium voltage distribution system may be subject to a much higher lightning voltage than the high voltage transmission systems. Surge recorder studies[1] on even the higher voltage systems have shown lightning voltages up to 15 times normal, this magnitude, however, being found infrequently. An alarming percentage of the surges seem to be of a dangerous magnitude, 10 per cent. of them having magnitudes from 6 to 10 times normal on some systems of 110 kv. and above.

The rate of rise of these induced lightning voltages is the subject of a great deal of experimental work being conducted on several systems during the present lightning season.

Theoretically, since the release of the bound charge must conform to the time for the cloud discharge, we have some basis for suppositions and it would seem that the rate of rise of the induced voltage would never be faster than the time for electricity to travel the distance from cloud to earth. Moreover, due to the character of the cloud as a conductor, the time to completely discharge the cloud would probably be appreciably greater. It appears that the time element in reaching the maximum induced voltage would seldom, if ever, be shorter than 1 or 2 microseconds and more probably of the order of 5 to 10 microseconds or even greater. Last year some data was obtained with the cathode ray oscillograph evidencing wave fronts of 5 to 10 microseconds. Efforts to deduce the proper wave fronts from surge recorder studies give the supposition that the great majority of the lightning surges have fronts slower than 10 microseconds. It should be remembered that these transient voltages induced from lightning are superimposed on whatever normal power voltage exists between the line wires and ground. Also, the induced voltage will occur simultaneously on all conductors of any multi-conductor circuit but will be of the greatest magnitude on the conductors having the greatest elevation above earth. This last has been repeatedly evidenced in practice where line insulator flashovers are most frequent on the top phase of vertically spaced 3-phase lines. The potential to which a line can be raised by lightning is quite independent of the length of the line, but involves only height and cloud potential gradient.

The Direct Stroke

In the parlance of the subject, a direct stroke is one where the lightning flash from cloud to earth terminates on the line conductor. A direct stroke will cause a voltage on the line having the same sign as the discharging cloud. The number of direct strokes in practice is very negligible relative to the induced effects. This is because only the strokes which would normally occur within a width of not more than perhaps four times the conductor height would be liable to strike the line. The maximum voltage which a direct stroke may occasion on a line conductor is not known, but theoretically the rate of voltage rise would be faster than an induced voltage. The potential to which the line may rise when subject to a direct stroke is limited by the insulator flashover, but the voltage of a resultant traveling wave might be higher, since the electromagnetic energy would be supplied by the lightning flash. If a direct stroke occurs on a line at a point midway between tower structure, it is practically certain that the flash will continue on and terminate at the earth below. If a stroke on the line occurred at a point only a few feet away from a well-grounded tower, the flashover of the line insulator to the tower might serve to complete the path of the stroke to earth. However, because of the tremendous potential gradient developed in and close to the lightning stroke, the presence of a nearby conducting path may not modify the course of the stroke to earth.

No attempt is made to design lightning arresters to withstand direct

strokes of lightning. The expense of such arrester design would be prohibitive to economy of arrester application. To prevent direct strokes terminating on station apparatus or a few feet away from it, means could be employed such as a Faraday cage or high and well-grounded towers near by which would divert the lightning stroke, but such methods would, as a rule, be unjustified because of the rarity of direct strokes in practice.

Traveling Waves

When a charge is moving freely along a line conductor the electrostatic energy must be equal to the electromagnetic energy. Such a freely moving charge is called a traveling wave. A traveling wave involves both voltage and current, the latter being necessary to the transfer of charge from one point to another. The capacitance C, per unit length of the conductor, charged to voltage E determines the electrostatic energy which is $CE^2/2$. The line inductance L per unit length of conductor and the current I determines the electromagnetic energy which is $LI^2/2$. Referring to Fig. 2, as soon as the bound charge on the line is set free by the lightning flash, a traveling wave begins to move out along the line in either direction, unless the bound charge occurred at the end of the line, in which case the wave travel would be in only one direction. When the bound charge is set free, the energy is all electrostatic, but in developing the traveling wave the charged portion of the line tends to discharge into a part of the line which is at some lower potential, and this transferring of charge must involve current flow in the line with resultant electromagnetic energy. When the traveling wave is complete the energy is divided equally between electrostatic and electromagnetic ($CE^2/2 = LI^2/2$) and the resulting waves cover just twice the length of line subject to the original bound charge. The electrostatic and total energy of the bound charge of length 's' was $\frac{1}{2} sCE^2$. The electrostatic energy of the traveling wave of length 2s is $\frac{1}{2}\, 2\, sCe^2$ or sCe^2. The total energy of the traveling wave of length 2s is twice the electrostatic energy and is, therefore, $2\, sCe^2$. The total energy of the traveling wave must be equal to the total energy of the bound charge from which it originated or $\frac{1}{2}\, sCE^2 = 2\, sCe^2$. Therefore, $E^2 = 4e^2$ or $e = E/2$.

While it can thus be shown that the traveling wave voltage is only half of the bound charge voltage originating the wave, it does not follow that traveling waves will be limited to a half of the insulator impulse flashover voltage. Dividing the induced voltage by two to get the traveling wave voltage is based on the premise of a given fixed charge developing into the traveling wave. In actual practice, the cloud does not discharge in zero time, but requires a finite time, and, therefore, the traveling wave starts when the first increment of the induced voltage appears, so that the traveling wave is developing during the time that the induced voltage is building up, with the result that the wave may be entirely in motion by the time that the induced voltage has risen to the flashover value of the insulators. It is, therefore, logical to presume the possible

existence of traveling waves of voltage magnitude approaching the impulse flashover of the insulators where insulators are grounded and of much greater voltage magnitude where insulators are not grounded. This is important in the consideration of voltage stresses at apparatus terminals.

The steepness of the front of the traveling wave induced by lightning probably depends upon the space distribution of the cloud field before the lightning discharge occurs, the proportion of the cloud discharging, and the rate of release of the bound charge. However, the greatest danger to insulation will occur at the point of origin of the induced potential and the terminal points where voltage reflections occur. At both of these points the voltage is higher and and wave fronts steeper than for the corresponding traveling wave. While the wave front and its maximum potential are of vital interest in the problem of protection, the shape of the remainder of the wave is also of importance. The body of the wave determines the length of time of application of crest potential and insulation may fail after the wave front has passed due to the prolonged voltage application by the body or tail of the wave. It must be remembered that the potentials resulting from induced or direct lightning strokes are of a decidedly transient nature and that the rate of voltage increase with respect to velocity of travel is such as to produce amazing potential gradients in a conductor. These enormous potential gradients over small space separations make the influence of lightning arresters restricted largely to the point of their installation on the circuit.

The name "surge impedance" has been assigned to the ratio of voltage E to current I in a freely traveling wave. The value of this ratio is determined on the basis of energy relationship, viz, $CE^2/2$ per unit length of line is equal to $LI^2/2$ per unit length, and the surge impedance Z will be equal to the square root of L/C. Thus Z varies with the relation of L to C in the circuit, and approximate figures are 500 ohms for overhead lines and 50 ohms for cables. While 500 ohms is sometimes mentioned for the surge impedance of a concentrated inductance such as a transformer winding, it is probable that the true impedance is variable for various parts of the winding.

The current of a traveling wave will be the voltage divided by the surge impedance, *i.e.* $I = E/Z$, and assuming 500 ohms for an overhead line, the traveling wave current will be 2 amperes per kilovolt of potential.

When a traveling wave on a line strikes an open end of a line a reflection results in which the energy becomes all electrostatic with double voltage and zero current during the reflection process. Such an open end of a line represents a surge impedance of infinity, and complete reflection occurs. If the wave from the line strikes a transformer or other concentrated inductance of relatively high surge impedance reflection also occurs with voltage becoming practically double and current practically zero during the reflection process. The final reflected wave has the same sign as the incoming wave. Since the voltage of a traveling wave may

be practically equal to the impulse flashover of line insulation, the reflection of such waves at terminal equipment may readily impose transient potentials greatly exceeding insulation strength of equipment.

When a traveling wave on a line strikes a short circuit between the line and earth, a reflection takes place in which the voltage at the point of short circuit is zero and the current double that of the wave current. The final reflected voltage wave will have the opposite sign of the incoming wave. Such a condition is had when the flashover of a line insulator occurs where the insulator is supported by a well-grounded tower.

The propagation of a wave is the result of current flow in the inductance of the circuit with the magnetic field tending to sustain the current flow. From Maxwell's theory, which has been checked by experiments, the velocity of wave travel is equal to the velocity of light, (3×10^8 meters per second), provided the dielectric constant and magnetic permeability are each equal to unity. If the dielectric constant is K then the velocity will be $1/\sqrt{K}$ times the velocity of light. For example, if a cable has a dielectric constant of 4, the wave velocity will be one-half that of a wave on a line in air. Magnetic permeability has a similar effect but is not so easily computed, since it is not a constant but is affected by flux density, skin effect, etc. However, it is seldom necessary to consider the permeability. In ordinary overhead lines it is convenient to consider the velocity as 300 meters (approx. 1,000 feet) per microsecond.

A traveling wave suffers attenuation during its propogation due to losses from corona, resistance dielectric, absorption, etc., the corona losses being predominant. Some surge recorder studies[3] and also surge investigations on line with the cathode ray oscillograph[4] indicate that lightning voltages attenuate fairly rapidly, the attenuation being a constant times the kv. squared (ke_o^2). The constant naturally varies with the size of the conductor, character of insulation, presence and proximity of ground wire, etc., and figures from .00016 to .0008 are found from data at hand. The attenuated voltage is $e = e_o/(kse_o + 1)$ Here s is the distance in miles for the original voltage e_o to attenuate to the voltage e. A figure for the constant k is .00016 which is probably conservative in showing less attenuation than might actually occur. Using this constant in mental calculations of attenuation, the distance that a wave will travel to attenuate to one-half value is equal to 6250 divided by the original voltage. For instance, a 1000 kv. wave will attenuate to 500 kv. in 6.25 miles and a 500 kv. wave will attenuate to 250 kv. in 12.5 miles. Since the higher voltage lines particularly are designed fairly close to the initial corona voltage, it follows that corona losses will continue to cause attenuation of a wave until the voltage is reduced to a value fairly close to the system voltage.

Internal Surges

Voltage surges giving rise to traveling waves and reflections occur in the normal operation of an electric system. Changes in the voltage or current flow, or modification of constants

of the circuit, are attended by a re-adjustment of the electrostatic and electromagnetic energies. This re-adjustment may be accompanied by oscillatory phenomena which may be very complex and often giving rise to destructive potentials localized in one or more points of the system. The character and magnitude of these switching and arcing ground surges are probably different for every system. Studies using surge recorders during the past three years indicate that the majority of switching surges are less than three times normal, normal being the crest value of the line-to-neutral system voltage. Switching loads on and off seems to produce relatively mild surges while energizing and de-energizing unloaded lines produce a worse condition. The majority of data has perhaps been obtained on the higher voltage systems and six or seven times normal represents the order of the highest switching surges, this magnitude occurring with the de-energizing of an unloaded line. The wave fronts of these switching surges are usually slower than the transients due to lightning and the time element and energy of the surge will, in general, impose no hardship on arresters.

The arcing ground surges will, of course, only occur on delta connected or ungrounded neutral systems. The arcing ground surges are recurrent as long as the ground fault exists. According to J. E. Clem[5], arcing ground surges may theoretically reach values of about six times normal and values slightly in excess of this have been shown on surge recorder studies. These arcing ground surges are a damped oscillation superimposed on the 60 cycle or system voltage and will cause continuous discharge of arresters on the two ungrounded phases for the duration of the ground fault. The energy of the surges depends upon the character and constants of the system. While the energy in any group of oscillations is small, the more or less continuous discharge of these surges through arresters tends to exceed the heat storage capacity of arresters and the prolonged arcing ground is unquestionably the most probable cause of arrester troubles.

Insulation

Electrical equipment and accessories are, in general, designed for a limited dielectric test. The test varies with different apparatus, depending upon the class of duty. The test voltage is generally defined by standards in terms of continuously applied voltage of commercial frequency for a specific time period when the apparatus is new. In order that a manufacturer can be sure of his article meeting such standard test he must design the insulation to incorporate some factor of safety, which varies over a fairly wide range for different manufacturers and different apparatus. Therefore, the actual failure voltage of new insulation is something above the test standard specified.

While the mechanics of insulation breakdown is not well understood, we can think of the sparkover of a gap or the puncture of an insulation as a tearing apart or change in the atomic or molecular structure. This process requires energy and, therefore time, because the power is never infinite. The process of disrupting the dielectric structure and

the building up of a spark through the dielectric starts at a fairly definite voltage gradient for a given insulation and pair of electrodes. After the process starts, some time must elapse before the sparkover takes place. This time element, while negligible at commercial frequencies, is conspicuously present in the transient voltage breakdown of a dielectric and is called time lag. The voltage to puncture a dielectric will vary in inverse relation to the duration of voltage application, giving rise to a hyperbolic volt-time curve. The impulse strength of insulation, therefore, can never be referred to as a single certain value, since any one value represents only one point on the curve. Likewise, the time lag to rupture a dielectric is not a constant, but depends upon the nature of the dielectric itself, the shape of the conductors and the resulting distribution of electrostatic flux and, more particularly, the rate of voltage application.

The line insulation appreciably influences the general lightning problem. Increasing the line insulation to reduce lightning flashovers on the line results in higher voltages which may be propogated along the line to terminal apparatus. With higher line insulation than is employed at the stations or adjacent to the stations there will be a tendency for increased number of flashovers near the station. Insulation flashovers in or adjacent to the station are probably undesirable. Such flashovers result in a chopped wave going on to the station apparatus. The tail of such a wave may drop from the insulator arcover value to zero in the time required for electricity to travel the distance of the arcover path. The chopped wave going on to the apparatus, therefore, has a sloping front but a vertical tail and the latter may cause dangerous turn-to-turn gradients in inductive apparatus or give rise to harmful oscillations. Moreover, on grounded neutral systems insulator flashovers in or adjacent to the station may be followed by a power arc and short circuit which are undesirable so close to the power source. Therefore, the choice of extra high line insulation renders the station equipment with standard or low insulation more susceptible to damage unless lightning arresters are employed to prevent the flashovers. As will be shown later, the arrester does not permit any dangerous chopped wave, and also prevents the short circuit following its operation.

Grounded Versus Non-Grounded Neutral Systems

There does not seem to be any reason for expecting a difference in the severity of lightning voltages occurring on grounded or non-grounded neutral systems. The magnitude of lightning potentials for either circuit depends upon the exposure of lines and their elevation above earth, the induced lightning voltage being the product of the change of cloud to earth voltage gradient and the height of the line conductors, the time element for the change in gradient being a factor. It would, therefore, seem that the number of apparatus flashovers or line insulator flashovers should not be affected by grounding the neutral, but the number of times that power current will follow the flashover and result in

short circuit and attending interruption will naturally be greater with the grounded neutral system. Lightning flashovers on the line, however, might not be followed by a power arc and short circuit if the short time lightning impulse happened to be superimposed at or very near to the zero point of the 60 cycle power voltage wave.

The switching surges are generally of lesser magnitude on the grounded neutral system and arcing ground surges are eliminated entirely, thereby removing a source of disturbance hazardous to lightning arresters. Considering inductive apparatus particularly, there is little or no data showing that the susceptibility to failure by lightning would be different with the Y or delta connection. However, with the inductive windings, delta connected impulses may enter the windings from both ends, but this may be offset by the fact that two windings in parallel present a lower combined surge impedance. The solidly grounded neutral system permits special arrester applications giving better protection at somewhat lower cost. The interpretation of solidly grounded in this consideration is, that the neutrals of all generating or other sources of power feed shall be permanently and directly connected to very low resistance grounds with no intervening reactors, resistance, fuses or switches so that under any condition of system switch operation the arresters can never be supplied by an ungrounded source and the neutral will be definitely fixed at earth potential. If the neutral is solidly grounded, the special grounded neutral arrester may be applied anywhere on the system regardless of length of transmission or isolation of stations. The grounded neutral arrester will, in general, give better protection, limiting the lightning stress to about 80 per cent. of that with the arrester for non-grounded systems.

System Voltage and Arrester Rating

The application of lightning arresters on any electric system involves essentially a consideration of the voltage conditions of the system. The lightning arrester is fundamentally a voltage device and properly designed operates independently of the transmitted current, power, size or number of generators supplying the system.

The voltages which must be considered are first, the normal operating system voltage ; second, the abnormal maximum system voltage ; third, the surge voltages from normal and abnormal operating conditions, such as switching and arcing grounds; and fourth, the lightning voltages induced on the exposed circuits. The first two voltage conditions govern the design of the arrester, the purpose of which is to limit the magnitude of the latter two classes of voltages.

While the rating of lightning arresters is based on the so-called standard system ratings, the arrester rating should, at least, be equal to the highest sustained line-to-line operating voltage of the circuit which might exist for any period, caused individually or collectively by high taps on transformers, over-excitation of generators, maximum boost by regulators or light load operation.

The design of the arrester based on the maximum sustained operating voltage alone is unwise, and the abnormal system voltage conditions must be considered to prevent the arrester from failing when these abnormal system voltages occur. Experience has shown that the abnormal system voltages are not generally serious on the lower and medium voltage distribution systems, so that the distribution types of arresters in general do not require the factor of safety in valve or sealing characteristics that is required of arresters for the higher transmission voltages. Loss of load and the attending overspeed of generators on transmission systems is a dominant factor in the design of station type arresters for these systems. The value of excess or runaway voltage depends upon the system set-up and resultant overall regulation and largely upon the speed-voltage characteristics of the generators. Studies of the latter have shown that steam driven machines may produce 50 per cent. rise and hydro-machines 100 per cent. rise above normal rated voltage, the worst condition being with direct connected exciters. Although these excess generator voltages exist for only a few seconds while the governors and voltage regulators are coming into action, the duration is entirely sufficient to destroy lightning arresters which discharge during this period of excess voltage. It has frequently been suggested that the spark-over voltage of the arrester gap be increased to a value above the maximum possible runaway voltage as a means of keeping this excess voltage off the arrester element, but this measure cannot be relied upon owing to the possible presence of transient surges with magnitudes of several times normal voltage which would still spark over the arrester gap. It is, therefore, necessary for the arrester valve element to be capable of preventing the flow of system current through it attending these extreme system voltages or to successfully interrupt the flow of such current without damage. Since the relief voltage and protective characteristic of most arresters are directly proportional to the 60 cycle sealing or valve voltage, it is obvious that protection is sacrificed by whatever percentage of factor of safety must be introduced in the arrester to withstand the excess system voltages.

A corrective measure to be preferred, is to limit the magnitude of the runaway voltages by the introduction of over-voltage or over-frequency control on the generators. Careful investigations evidence that it should be possible to limit the runaway voltage of generators to a maximum of 25 or 30 per cent. above normal and do this with sufficiently positive performance to justify designing arresters for only slightly above the voltage as limited by this means. It will be obvious to all, and particularly to those operating engineers who are placing increasing dependence upon arresters, that so limiting the maximum system voltage is far more rational than accepting 50 or 100 per cent. possible voltage which acceptance demands that all of the arresters for the system cost more and give less protection. The cost of the means of limiting the overvoltage of the generators would be

saved in the cost of a very few arresters and, while the major benefit would be in improved protection at less cost, the elimination of the extreme runaway voltages from all apparatus is desirable.

Often one circuit may be exposed to an excess 60 cycle voltage by induction from a higher voltage circuit, making it necessary to consider the induced voltage in applying arresters. In one instance, a 550 volt circuit closely paralleled a 120 kv. line and short circuits on the latter caused a voltage of about 2,000 to be induced on the 550 volt circuit for the duration of the short circuit. This induced voltage was a 60 cycle voltage sustained for a matter of seconds and necessitated arresters having a valve element designed for 2,000 volts instead of for the normal 550 volt rating of the circuit.

Lightning Arresters

The duty on lightning arresters and their response to that duty is the subject of continued investigations and operating engineers have just reason to expect for the future even greater immunity from lightning failures than now experienced. The cathode ray oscillograph has for several years enabled exacting studies in the laboratory of arrester protective characteristics, and more recently on actual transmission lines. This, together with the several investigations being conducted this season with cathode ray oscillographs for determining the magnitude and wave shape of lightning on actual lines are very definite advances which will continue to stimulate developments and improvements in arresters and their application for maximum benefits.

The percentage by which an arrester reduces the voltage of a lightning impulse or wave depends on the relation of the arrester resistance plus the ground resistance to the surge impedance of the circuit at the point of installation. This relationship of discharge path resistance to surge impedance can be plotted and is shown in Figs. 3, 4 and 5 for the cases most common in practice. Fig. 3 is the most common case for an arrester connected from line to ground at a transformer terminal, the transformer being at the end of the line. The surge impedance of the line Z_1 is assumed to be 500 ohms and that of the transformer Z_2 assumed to be 5,000 ohms. The discharge path resistance in ohms is plotted against

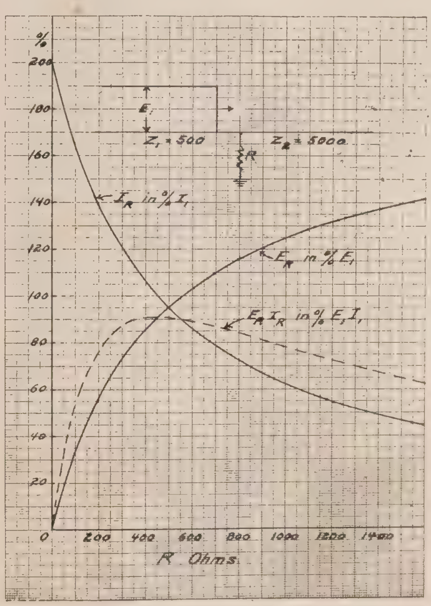


Fig. 3—Current, Voltage and Power relations with travelling wave. Arresters at junction of line with high surge impedance.

the discharge path voltage and current in percent of the incoming wave voltage and current. It will be seen that if the discharge path resistance is zero, the voltage across it is zero, and the current through the discharge path is 200 per cent. of the wave current, this condition constituting a so-called current reflection which results in a voltage wave of opposite sign equal to E_1 being reflected back on the line. If the resistance is 100 ohms the incoming wave is reduced to 33 per cent. and the current through R is 163 per cent. of the wave current on the line. The reflected voltage wave of opposite sign will be the difference between 33 per cent. and 100 per cent. or a wave of 67 per cent. of E_1. If the resistance R is 500 ohms, which is equal to the line surge impedance, the voltage across R and the current through R are 95 per cent. of the voltage and current on the line. If Z_2 had been infinity as with an open ended line the resistance voltage and current would have been 100 per cent. and the wave would be completely absorbed in the resistance. The assumed transformer impedance changes the condition but slightly from the case of an open ended line. The dotted curve shows the energy absorption from the incoming wave E_1 for the various values of R.

Fig. 4 is a similar plot but for the case of the arrester along a line where the surge impedances on both sides of the arrester are equal. It is seen that if R is 100 ohms in this case, the voltage across R is about 29 per cent. of the incoming wave and the current through R is 143 per cent. of line current. The difference be-

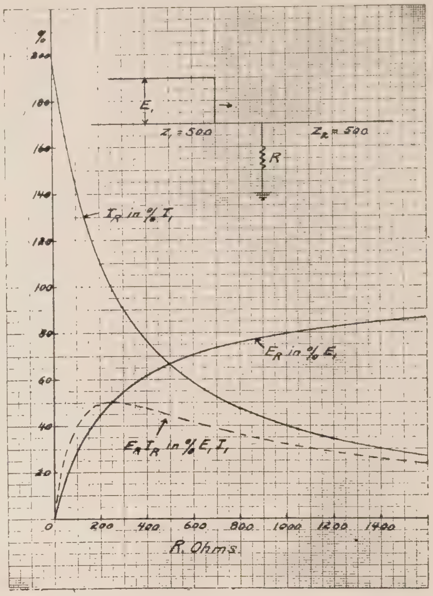


Fig. 4—Current, Voltage and Power relations with travelling wave. Arrester at mid-point of line.

tween 29 per cent. and 100 per cent. is the proportion of the incoming voltage which is reflected of the opposite sign. It is seen that for any value of R the voltage across R is lower. It is also noted that the maximum absorption in R occurs when R is about 250 ohms and that under this condition only 50 per cent. of the incoming wave energy is absorbed.

In Fig. 5 we have the same plot but for the case of an arrester at the junction of overhead line and cable which is long in comparison with the incoming wave, the surge impedance of the cable assumed to be 50 ohms. Here it will be seen that with R of 100 ohms the voltage across R is 12.5 per cent. of the incoming wave voltage and the current through

R is 62 per cent. of the line current. For maximum absorption in R the latter must be about 50 ohms and when so the absorption is only 10 per cent. of the incoming wave energy.

There are two desirable accomplishments for arresters. First, and most important, to reduce the voltage of waves at the arrester terminals and second, but less important, to absorb as much as possible of the wave energy so as to minimize the amplitude of the reflected wave and its energy. That both conditions cannot be obtained is evident. The condition for maximum absorption demands that the arrester resistance be such that the arrester does not appreciably reduce the voltage at its terminals below that dictated by the circuit surge impedances. To limit

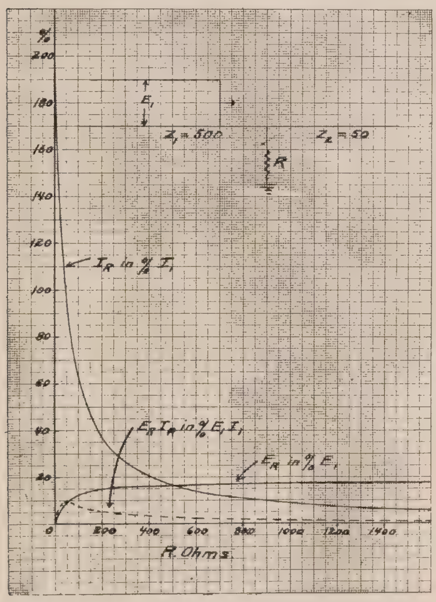


Fig. 5—Current, Voltage and power relations with travelling wave. Arrester at junction of line with cable or other low surge impedance.

the voltage at the arrester to such value as would be considered good protection requires the arrester resistance to be very much smaller than that which permits maximum absorption. The curves indicate that lower resistance discharge paths are necessary in distribution arresters than are necessary for the higher voltage arresters. For instance, a 2,300 volt distribution circuit might be subject to a lightning voltage of 300 kv. and if it is desired to limit the stress on a 2,300 volt transformer to 15 kv. the voltage across the arrester and ground resistance must be 5 per cent. of the wave voltage, thus requiring the discharge path resistance to be of the order of 10 ohms. For the high voltage system the line insulation more commonly limits the lightning voltage to around 10 or 15 times the normal line to neutral value and the high voltage arrester does not have to reduce the possible lightning voltage to as low a percentage to give complete protection. For instance, the maximum lightning voltage as limited by the usual 110 kv. insulation would be in the neighborhood of 1,100 kv. and if an arrester reduces this to 400 or 500 the protection is quite satisfactory. To hold the voltage to 40 or 50 per cent. permits the arrester resistance to be of the order of 100 to 200 ohms.

The most complete definition of an arrester's protective performance is shown by the impulse volt-ampere cathode ray oscillogram. This shows just how the voltage across the arrester is affected by various magnitudes of current through it, and

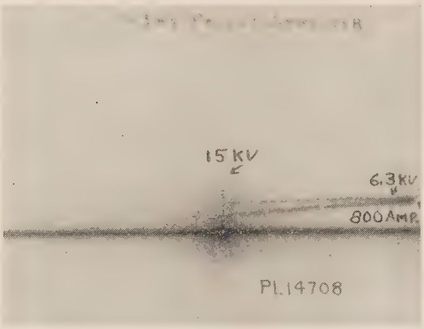


Fig. 6

therefrom, how the arrester resistance behaves. It also enables a definite differentiation between breakdown voltage and the IR voltage drop across the arrester.

It is generally conceded that the protective characteristic of an arrester should provide a horizontal or nearly horizontal volt-ampere characteristic in which the voltage across the arrester is nearly independent of the amplitude of discharge current. Dividing the voltage ordinates by the current abscissæ indicates that the internal resistance of the arrester must decrease rapidly with increasing current and that the actual resistance of the arrester for any discharge in practice depends upon the amplitude of the discharge current.

Fig. 6 is a cathode ray oscillogram of a 3 kv. pellet arrester obtained on a fairly steep impulse which produced 800 amperes discharge through the arrester. The horizontal volt-ampere characteristic shows a crest voltage of 6.3 kv. allowed by the arrester. A value of 15 kv. occurred for the instant of gap breakdown, that is, up to the time that current begins to pass through the arrester. While it would be unquestionably desirable to eliminate this higher gap breakdown voltage, it is believed that the effect of these extremely brief over-voltages are of less significance than the main IR characteristic since the latter may endure for a much longer period. In limiting the voltage to 6.3 kv. which is about 2.1 times the arrester 60 cycle rating, the arrester impedance was down to about 8 ohms at the maximum discharge current.

It must be remembered that the protective characteristic in practice can be greatly altered by the presence of the ground resistance in series with the arrester between line and earth. Fig. 7 is a cathode ray oscillogram of the same arrester in series with an actual driven ground which had a 60 cycle measured resistance of 55 ohms. It is seen that the volt-ampere characteristic of the combination is no longer horizontal but the voltage increases appreciably with increasing current. It is interesting to note that the impulse resistance of the ground at the maximum current was about 41 ohms which is somewhat below the 60 cycle measured value of 55 ohms[(6)]. This order of ground resistance is above what is

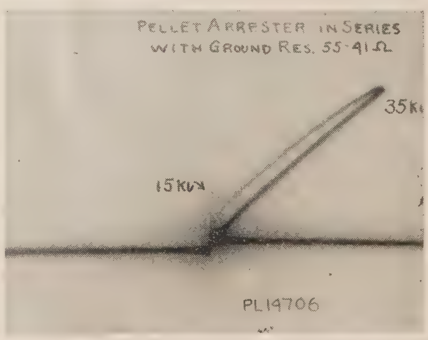


Fig. 7

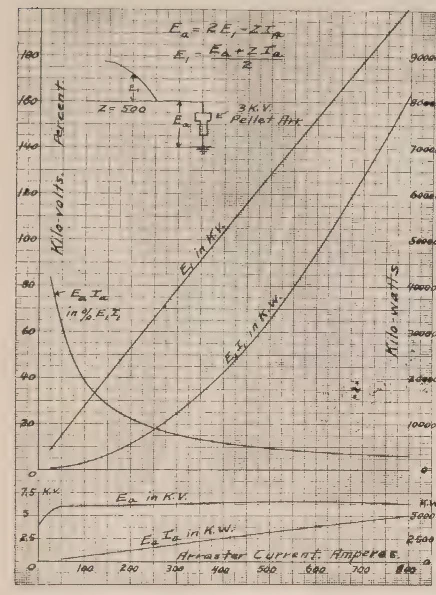


Fig. 8—Current, Voltage and Power relations with travelling wave. 3 kv. Pellet lightning arrester at end of line.

ordinarily recommended in distribution practice, 15 ohms being a desirable maximum.

From the horizontal volt-ampere characteristic in Fig. 6 it is possible to plot the wave voltage, wave energy, arrester voltage and arrester energy against the arrester current. Fig. 8 shows these relationships based on the upper or rising part of the volt-ampere characteristic. These curves indicate that a voltage wave of about 130 kv. would cause a 500 ampere discharge through the arrester. The voltage across the arrester is less than 5 per cent. of the wave voltage. The energy rate of the wave (E_1 I_1) would be about 32,500 kw. and the energy rate absorbed in the arrester would be about 3,200 kw. The arrester kw. in per cent. of the wave kw. is shown to be about 10 per cent. A wave voltage of 40 kv. would cause about 150 ampere discharge through the arrester and the arrester would reduce the voltage to about 15 per cent. The kw. in the arrester would be about 28 per cent. of the kw. in the wave.

Conditions more truly representing service performance are shown in Fig. 9 which is similar to Fig. 8 except that 15 ohms ground resistance has been introduced in series with the arrester. A wave of 132 kv. would cause current of 500 amperes through the arrester. Due to the presence of the 15 ohm ground resistance, however, it will be seen that the kw. rate in the arrester is 20 per cent. A 40 kv. wave would cause about 150 amperes discharge current and the

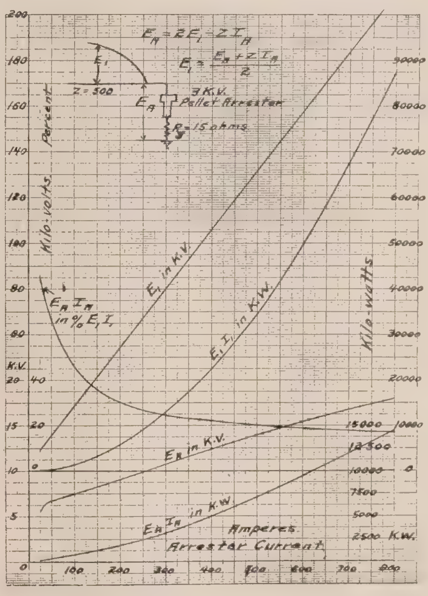


Fig. 9—Current, Voltage and Power relations with travelling wave. 3 kv. Pellet lightning arrester and 15 ohm resistance at end of line.

kw. in the arrester is about 36 per cent. of the wave kw.

If a wave strikes the open end of a line without an arrester, the voltage E reflects to 2E. Fig. 10 shows the voltage with the arrester in per cent of 2E for various values of discharge current with and without the 15 ohm ground resistance.

The actual energy in the wave and that absorbed in the arrester can only be stated after time is known and for the practical case the energy is in watt seconds, owing to the extremely short duration of the wave or impulse on the line.

The ground resistance in series with the arrester plays a very important part in the final protective performance and in the amount of absorbed energy and the resultant reflected voltage wave and its energy. There seems to be merit in designing for the lowest volt-ampere characteristic in the arrester, thus providing the maximum voltage reduction by the arrester which it is possible to attain. This seems logical from three viewpoints. First, the arrester is generally installed to protect a given piece of apparatus against not only the moderate but the most severe surges of both original and reflected origins. To protect against the severe surges the arrester voltage must be a very small percentage of the wave voltage and this requires low internal resistance in the arrester and resulting voltage reflections of opposite sign back onto the line. Second, that any reflected voltage wave, even with the lowest resistance arresters, will always be less than the incoming wave and if the latter would not cause line flashover the reflected wave of lesser magnitude will be equally harmless. Third, the difficulty of obtaining low resistance grounds insures that the majority of installations will have enough resistance in series with the arrester so that the combination gives quite an appreciable absorption of the wave energy. Moreover, the lower the volt-ampere characteristic and resistance of the arrester the less expense necessary for arrester grounds to obtain a given degree of protection. For instance, an arrester with an IR voltage of 6 kv. and a 33 ohm ground will afford the same degree of protection as an arrester with an IR drop of 15 kv. and a 15 ohm ground both having a 500 ampere discharge. For a moderate discharge current of 100 amperes, the former arrester with

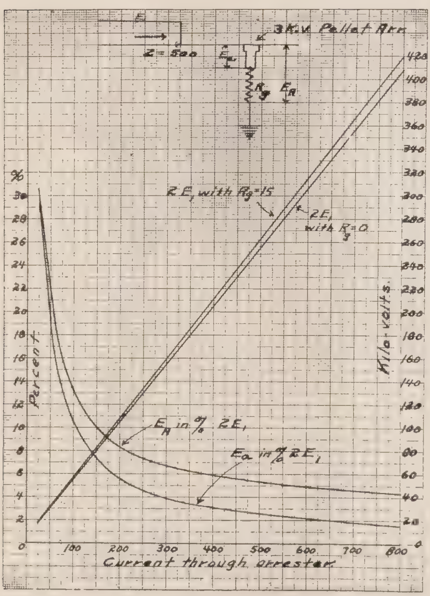


Fig. 10—Current-Voltage curves with travelling wave. 3 kv. Pellet lightning arrester with and without 15 ohm resistance at end of line.

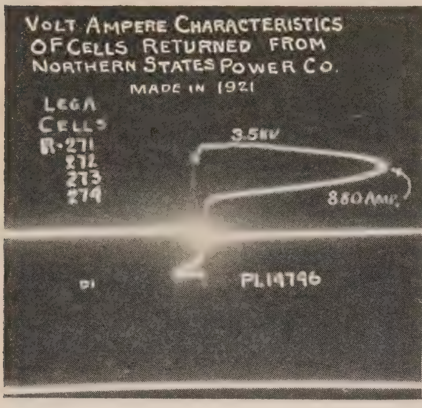


Fig. 11

a 100 ohm ground will afford the same degree of protection as the latter arrester with a 15 ohm ground.

While it is desirable to have low ground resistances with arresters of all ratings to gain maximum protection, it is obvious that a high ground resistance will more seriously penalize protection on the lower voltage circuits, because on the lower voltage circuits the surge voltage must be reduced to a very small percentage of the possible lightning voltage on these circuits.

Fig. 11 is a volt-ampere characteristic typical of the oxide film station type arrester. This oscillogram was obtained on four OF cells in series after eight years of service operation. The voltage at which current begins to flow through the arrester depends somewhat on rate of voltage rise but for waves reaching the arrester breakdown in one or two microseconds, the arrester begins to pass current at about 1 kv. crest per cell. It is seen from the characteristic that as discharge current increases through the cells the voltage across them decreases. At the instant of maximum current the voltage across the cells is about 600 to 700 volts crest per cell. This value is more or less independent of magnitude of discharge current or steepness of applied voltage wave. It has been established from many tests on different numbers of cells in series that there is a straight line relation between number of cells in series and voltage across them. This relationship enables us to draw the volt-ampere curve for any number of cells if we have obtained the volt-ampere characteristic of a smaller number of cells by oscillographic tests.

Fig. 12 shows a volt-ampere curve for a 33 kv. arrester based on the oscillogram Fig. 11. This arrester has 127 cells per phase from line to ground.

If this arrester were connected at

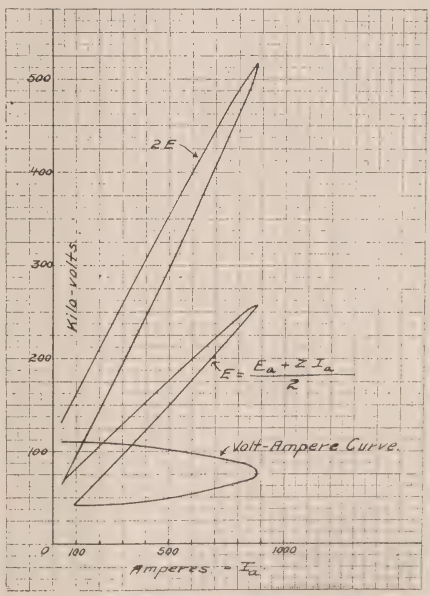


Fig. 12

the end of a line having surge impedance Z equal to 500 ohms, the incoming traveling wave of voltage necessary to produce this current wave through the arrester is shown by the curve marked E. The values of E are obtained from the formula shown on the curve, where E_a and I_a are the arrester voltage and current. The voltages 2E are the corresponding values which would be reached by reflection if there were no arrester.

The curves in Fig. 12 can be used to plot volt-time curves as shown in Fig. 13. An incoming voltage wave E is assumed which reaches its crest in about 5 microseconds, a time probably corresponding to waves in practice. The voltage on the arrester rises at the rate 2E due to reflection of E until the arrester begins to discharge and reduce the voltage. It is of interest to compare curve 2E with the curve E_a. Curve 2E shows the voltage which would occur without the arrester while E_a shows the voltage as limited by the arrester. The oscillogram Fig. 11 shows that the voltage across the arrester decreases with increasing current and for this reason the arrester voltage decreases while the incoming wave voltage E is increasing, as shown in Fig. 13.

Fig. 14 shows similar curves for a 110 kv. arrester having 424 cells line to ground, but based on a different volt-ampere characteristic. The incoming voltage wave E was assumed to reach 1,100 kv. in 5 microseconds.

Five ohms or less is the usual recommended value of ground

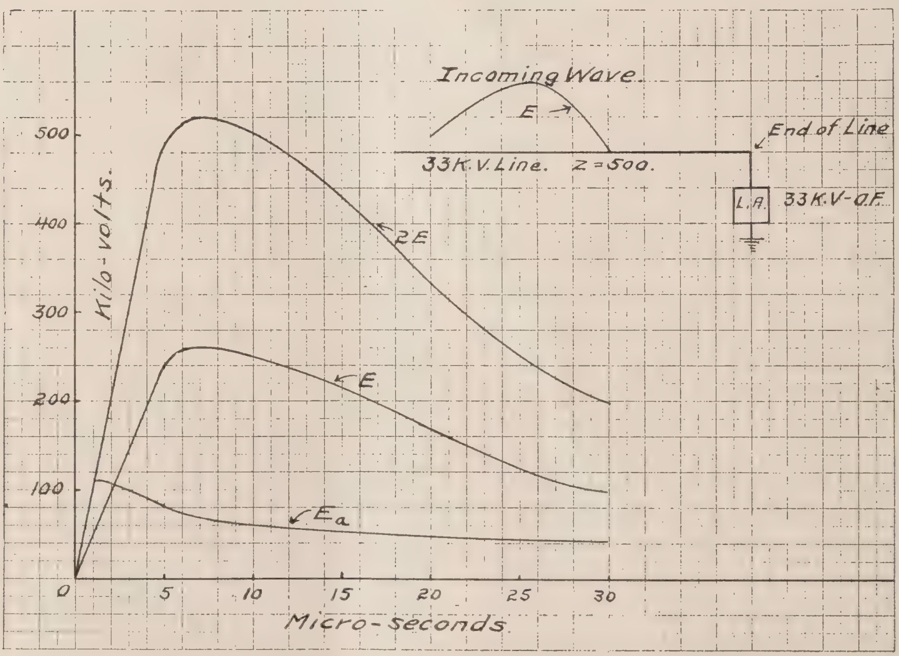


Fig. 13

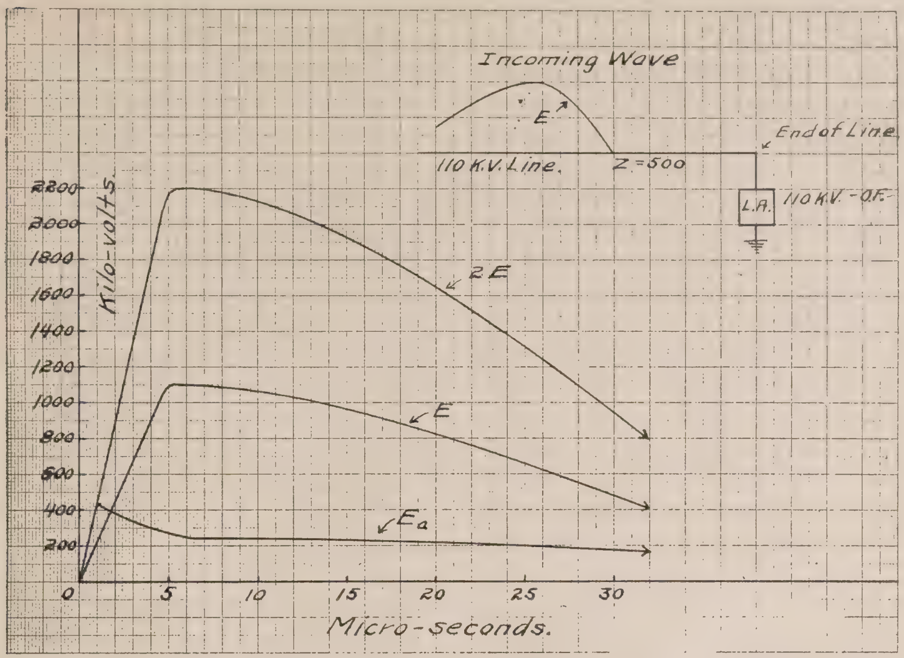


Fig. 14

resistance for station arresters and by interconnection of arrester ground with station ground the effect of ground resistance becomes negligible.

Location of Arresters

The scientific application of lightning arresters demands first, the recogniton of the extreme transient or steep wave front nature of the dangerous potentials involved with the direct or indirect effects of lightning, and second, the acknowledgement of the hyperbolic volt-time breakdown characteristic of apparatus insulations in which the voltage to cause failure becomes lower with increased time of voltage application. These fundamentals, together with the fact that the effects of repeated applications of excess voltage on apparatus insulation may be more or less cumulative, make the relative location of the arrester a pertinent factor in the problem of protection.

Extensive service experience, laboratory tests, and theoretical considerations point to the greater security of a distribution transformer against lightning damage when the arresters are on the same pole, which of necessity means that the arresters are close to the transformer. In transmission practice involving the larger station type arresters at particularly the higher voltage generating and substations, the physical arrangement and extent of apparatus makes it rarely possible to place the arrester directly adjacent to the transformer or other apparatus to be protected. However, the handicap of arrester separation in the larger stations may often be more or less counterbalanced by the favorable action

of the electrostatic capacitance of the terminal apparatus or station structure and the decreased surge impedance brought about by the termination of the line into multiple circuits and buses in the station. When a traveling wave reaches such an installation involving a comparatively low surge impedance in buses and connections, and a relatively concentrated capacitance in the apparatus, the wave front is sloped off so that the voltage gradient on the circuit between the arrester and the other apparatus will be very much less than the gradient over a similar length of circuit on the open line. The equivalent surge impedance of the complex circuit is equal to the reciprocal of the sum of the reciprocals of the impedances of individual circuits. The percentage decrease in voltage is about twice the percentage decrease in surge impedance. Expressed more exactly, if the surge impedance is reduced to 1/10 the wave voltage is reduced to 2/11, the formula being

$$E_2 = E_1 \frac{2}{1 + Z_1/Z_2}$$

This, however, does not include the increase in voltage due to reflections at far end of the Z circuits. Since the steepness and length of the incoming wave is unknown it is impossible to definitely evaluate the benefits of the aggregate surge impedance and the action depends upon the electrical and physical set-up of each individual case. The best engineering practice, therefore, is to place no particular dependence on this action but rather to locate the arrester as close as practicable to the transformers or other apparatus to be protected. Where the separation between arrester and transformer is of necessity several hundred feet it may, in some cases, be desirable to shield the intervening circuit and buses with several overhead grounded conductors which serve to decrease the potentials induced on the station side of the arrester and minimize the reflections of the arrester voltage at the terminals of inductive equipment.

Where lines enter a station through cables, the latter should be protected at the junction of the line and cable. While Fig. 5 indicates that the low surge impedance of the cable will greatly reduce the value of incoming voltages, reflections within the cable progressively increase the stress on the cable insulation and if the length of the incoming wave is great compared to the length of the cable, thus permitting several reflections each with its increased voltage in the cable, the stress on the cable insulation may ultimately approach the voltage of the incoming wave. From a case calculated, if the original incoming wave was 20 times the length of the cable, the voltage of the latter could be built up by the successive reflections to nearly 90 per cent. of the wave voltage on the line Dielectric losses in the cable account for very negligible absorption of energy. It must be remembered that when a wave leaves the cable in the station the voltage approaches double at the junction of the cable and open station wiring and that this voltage again approaches double where the station wiring terminates at a transformer or other inductive equipment. It is, therefore, desirable to have an arrester on the station bus in addition

to the arresters out at the junction of the overhead lines and cables.

A scheme which, apparently, has some merit but which has probably not been tried is to extend a cable 3 or 4 spans along the poles with the sheath insulated from ground so that a portion of the wave is transferred from the exposed line to the sheath. The sheath can then be grounded through a resistance to absorb this wave energy.

Probably one of the most difficult protective problems is that involved with rotary apparatus directly connected to exposed overhead lines. The space factor in rotary equipment, together with the fact that insulation must operate dry and without reinforced end turn insulation, generally results in a smaller factor of safety in insulation than is obtained with transformers. There are many cases in practice where generators or motors are directly connected to exposed feeders and satisfactory protection of this equipment requires reducing the line surges to a very minimum at the terminals of the apparatus. Extremely low ground resistance is imperative and the arrester should be close to the apparatus terminals to avoid the increased insulation stress due to reflection. Where the insulation strength is below normal and the voltage reduction by arresters does not prove sufficient for protection, it may be desirable to introduce a one-to-one insulating transformer between the rotary machine and the exposed line.

Line Protection

While the greatest economy in lightning protection unquestionably lies in the application of arresters at the stations and apparatus terminals, the increasingly critical attitude towards line flashovers and service interruptions is directing a great deal of thought to the problem of protecting the line insulation against flashover. With the grounded neutral circuits the flashover of line insulation by lightning will usually result in a service interruption, but this actually depends upon the point of the 60 cycle wave at which the lightning impulse occurs. If the impulse happened to occur while the 60 cycle voltage was passing through zero a follow current arc would be unlikely and no interruption would ensue.

There seem to be four measures which might be looked to either individually or in combination to reduce the service interruptions from line flashovers. These are first : the overhead ground wire ; second, lightning arresters liberally applied along the line ; third, the use of fused grading shield assembly on insulator strings ; and fourth, the employment of the Peterson grounding coil or reactor. The first two measures are in the way of eliminating or reducing the lightning voltages on the line to a value below line insulation flashover. The second two measures do not alter the magnitude of the lightning potentials on the line, but prevent the operation of breakers and service interruption following a lightning flashover.

It is, of course, entirely feasible, though not generally economical, to design transmission lines for immunity from lightning flashover. A 220 kv. line has recently been considered with this result in mind.

The average height of the line conductors is kept down to about 36 feet and assuming the maximum possible cloud-to-earth gradient to be 100 kv. per foot, the possible induced voltage on the line conductors would be 3,600 kv. Two overhead ground wires are assumed to reduce this voltage by 60 per cent. to about 1,450 kv. The line insulation together with the grading shields has a flashover of 2,300 kv. Theoretically, there should be few if any induced lightning flashovers on such a line, but experience is still necessary to confirm this anticipation. It would seem that the cost of lightning interruptions to service after a line is in operation might justly be applied toward constructing the line for greater immunity from lightning flashovers. The greatest single factor lies, unquestionably, in minimizing the height of the line above earth. The lower the line, however, the less the effect of overhead ground wires.

Overhead ground wires have come into almost universal favor and service records and line interruptions, together with surge recorder data, evidence a very marked reduction in line troubles by their use. A 50 per cent. reduction in induced voltage by a ground wire may mean an 80 or 90 per cent. reduction in the number of flashovers. In addition to reducing the induced voltage, the ground wire increases the attenuation in wave travel along the line. The actual protective benefits of the ground wire in percent. reduction of induced voltage depends upon the height, physical configuration, and how frequently and effectively the ground wire is earthed. The cost of the overhead ground wire varies through a fairly wide range, depending on the construction, but for the higher voltage lines the cost will probably run from \$500 to \$1,000 per mile. The overhead ground wire does not dispense with the need for arresters at stations.

The application for arresters along the line to prevent insulation flashovers has often been proposed, but the cost of arresters has been a prohibitive factor except in a few instances. Such instances are where repeated line flashovers occurred at badly exposed points, such as where a line crossed over high, rocky topography and arresters at such points have greatly improved service reliability. The fact that lines are being constructed with two and occasionally three overhead ground wires evidencing an expenditure of \$1,500 to \$3,000 per mile mainly to reduce line flashovers is evidence that arresters of the proper physical proportions for line application is a worthy consideration. The arrester for line protection would not have to present as good a protective characteristic as is considered desirable for station protection, and, thus, the line arrester could have higher internal resistance which would permit more energy to be absorbed. A poorer protective characteristic is justifiable because first, repeated applications of voltage just below the insulator flashover would not be cumulative and, therefore, if the arrester held the voltage to 15 or 20 per cent. below the insulator flashover the result would seemingly be satisfactory. Second, that reflections of the arrester voltage to double value which can occur at the terminals of inductive apparatus in

the station would not be possible with the line arrester application. On the other hand, the line protection problem is dealing with air dielectric wherein the impulse ratio is generally less than that in the apparatus involving composite, solid and liquid insulations. The natural question is how frequently line arresters would have to be applied to entirely prevent insulator flashovers. This would seemingly depend entirely upon the steepness of the lightning waves on lines and the resulting potential gradient along the conductor, as well as the attenuation factor. The question can probably not be answered until more data is available on the actual wave fronts from lightning, which data should be forthcoming this season. An idea of the wave fronts will permit a good speculation on the permissible separation of the arresters along the line, but any theoretical conclusion would have to be confirmed by practical experience.

In considering line arrester application, it is noteworthy that benefits may be expected from applying the arresters on only one phase or conductor of the line. If the discharge of the arresters on the one phase appreciably reduces the voltage on that phase, the latter will cause a lesser reduction of the voltage on the other two phases by capacitance effect. The reduction of voltage on one phase by the arresters enables that phase to partially simulate an overhead ground wire in affecting some voltage reduction on the other two phases. In such an application to lines having other than horizontal arrangement the arresters might be put on the highest conductor or phase wire which would be subject to the highest induced lightning voltage.

While the fused grading shield assembly[7] seems to have some merit in preventing line interruptions following lightning flashovers, the scheme has the objection of requiring frequent patrol of the line and fuse replacements. Service data on this scheme merits careful observation.

A Peterson grounding coil or reactor inserted between the neutral and earth seems to be entitled to consideration. The Peterson coil is enjoying considerable favor among European engineers, but only one or two experimental installations have been made on this continent. With such transmission problems as instability and the extremely heavy short circuit currents imposing extreme duty on circuit breakers on transmission systems, there is some tendency to favor grounding the neutrals through either resistance or reactance. In general, the reactance is said to be cheaper. While the ohmic value of neutral grounding resistances and reactances in use is below that of the Peterson coil, there seems to be increasing discussion and some favor toward going all of the way to the Peterson coil in the neutral.

The Peterson coil supplies the charging current to ground of the two non-grounded lines when one becomes grounded. The reactance is so proportioned that this charging current will provide full leg voltage across the reactor. This accomplishes two things. First, it provides a path of low impedance for the charging current, thus shunting it away from the flashover ground fault.

Second, it provides a path of high impedance to the short circuit current through the fault. The combined effect is to enable the fault to clear without switch operations.

References

(1). Transmission Line Insulation and Field Studies Pertaining to Lightning, by W. W. Lewis, presented at High Tension Conference, Paris, 1929.

(2). Progress in Lightning Research in the Field and in the Laboratory, by F. W. Peek, Jr., A.I.E.E. Winter Convention, New York, January, 1929.

(3). Surge Voltage Investigations on Transmission Lines, by W. W. Lewis, A.I.E.E. Summer Convention, Denver, June, 1928.

(4). Cathode Ray Oscillograph Study of Artificial Lightning Surges on Turners' Falls Transmission Line, by K. B. McEachron and V. E. Goodwin, A.I.E.E. Regional Meeting, Cincinnati, March, 1929.

(5). Arcing Grounds and Effect of Neutral Grounding Resistance or Reactance, by J. E. Clem, to be presented A.I.E.E.

(6). Impulse Characteristics of Driven Grounds by H. M. Towne, November, 1928, *G. E. Review*.

(7). Fused Arcing Horns and Grading Rings, by Philip Stewart, A.I.E.E. Regional Meeting, Cincinnati, March, 1929.

E.I.C. Welcome Arch at Peterborough

The activities of the Peterboro Branch of the E.I.C. in connection with the "Old Home Week" celebration shows a very good and highly exemplary interest in local affairs. A few years ago they contributed a reproduction of the Quebec Bridge as a "Welcome" arch. This year they have gone into the electrical field and as the accompanying photograph indicates they have used parts of transmission towers for supporting an electric sign. This featuring of electrical developments of Ontario at such functions as "Old Home" weeks is, we are sure, appreciated by all who are interested in that industry.

Considerable competition may develop between electrical organizations of various municipalities in the effectiveness of electrical displays or "Welcome" arches at various civic functions. We think the E.I.C. and the local electric fraternity have established a fairly high standard in case such competitions materialize.

Factors Governing the Design of the 115-230 Volt Distribution at High Load Densities

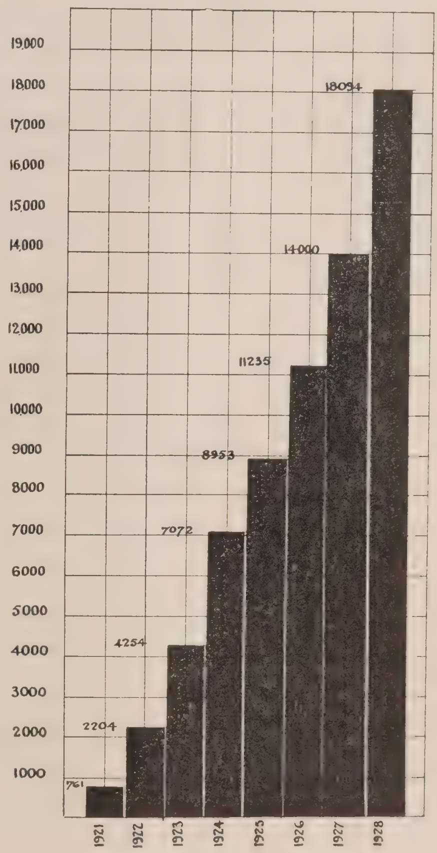
By G. L. Lillie, Distribution Dept., Hydro-Electric System, Toronto

(Read before Association of Municipal Electrical Utilities at Bigwin Inn, Lake-of-Bays, Muskoka, July 5, 1929)

AT the end of the year 1921 there were approximately 761 ranges connected to the lines of the Toronto Hydro-Electric System. Since then, over 17,000 ranges have been added and at the end of 1928 we had more than 18,000 on our records. This is an average of approximately 2400 per year. Last year alone more than 4,000 new range loads were actually connected. Fig. 1 illustrates the growth of this class of load. I believe this represents conditions throughout Ontario and as we are favourably treated in the matter of rates for electric cooking and as in Toronto we may have a maximum concentration of this class of load, it has become especially necessary that we give serious thought to the most economical methods of supplying these services, and at the same time maintain our standards of line construction. That is, secondary and primary extensions must not be laid out in a haphazard way, but a definite plan of distribution should be followed, particularly with respect to the size of secondaries and the spacing and size of line transformers.

At one time the lighting peak made up our maximum demand on house lighting transformers in the residential districts and by taking readings of current at regular intervals between the hours of approximately six and ten p.m., we knew the loads carried, and could arrange for additional capacity, or make new extensions as required. This is, however, completely changed. Range loads in most residential districts govern the situation and their peak is higher and generally comes much earlier, though

Fig. 1



at certain periods of the year there is some overlapping.

In January 1921, Mr. C. E. Schwenger presented a paper before this Association on the Economical Handling of Range Loads on the Distribution System, and it was with the idea of checking up conditions found at that time with our present day problems that this investigation was undertaken. At that time we had less than 800 ranges, as previously mentioned, and now we have over 18,000. What has been or what should be our development, from a distribution point of view, to handle this concentrated load ?

To begin with, a large number of maximum demand tests were made on different street locations throughout the City. These were arranged to include various classes of residential customers. Also, different types of line construction were used. Of these, the most representative are listed in Table No. 1 and a study made of same.

Referring to this table, we note that test section A is the same as was checked 8 years ago and readings now show that although the number of customers has been reduced on account of part of the line being cut over to another transformer bank, the maximum demand per 1,000 ft. has been increased by 15.5 kw. In section B the length of secondary has remained the same as before but the size has been changed to No. 0 on account of increased load. The number of customers has increased 28 per cent., the number of ranges has increased 38 per cent. and the maximum demand has increased 22.3 per cent. These test sections cover medium class houses of six to seven rooms and of about $7,000 to $8,000 in value, built close together on lots of about 30 ft. frontage. They became early users of electricity for cooking, no doubt mainly due to the fact that when this district was first built there were no gas mains on the streets. Gas is now available but electricity still predominates.

In C and D we have somewhat newer streets, but otherwise conditions are quite similar. The percentage of ranges is somewhat higher and the maximum demand higher still. In section E, we have larger residences and larger frontages. This street was short but the percentage of ranges higher and the maximum demand per 1,000 ft. still as good as in section C. In section F, houses of approximately $15,000 to $20,000 in value were checked. G and H sections were taken in one of the best modern residential parts of the City, and when the maximum demands per 1,000 ft. are noted, it must be remembered that the frontages in these cases are 50 to 100 ft. instead of 25 to 30 as in the first locations tested. In Test Section H, a complete transformer bank supplied by two pairs of buried 37½ kw. transformers, was checked. Recording ammeters were installed on the primary supplying same. In this case, the writer took the trouble to note how many residents were away from home while the demand peak was being made. At least seven or eight out of a total of 68 customers were not present, which, of course, would increase the possible maximum demand for the section.

In section I, we have a 100 per cent.

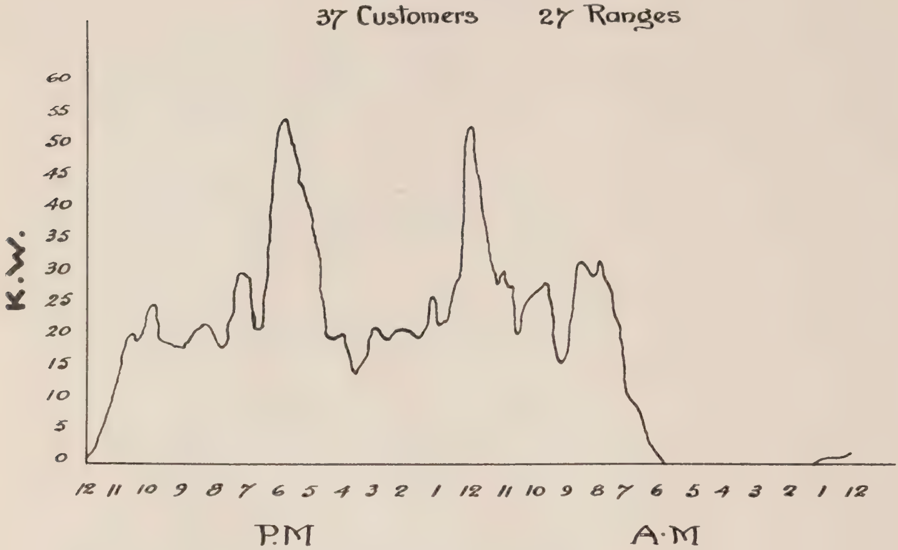
TABLE NO. 1.

TEST SECTIONS.

	No. of Consumers	Houses Wired	No. of Ranges	Sec. Length and Size	Percent of Ranges	Connected Load Kw.	Max. Demand Kw.	Demand Factor Per Cent	Demand Per 1,000 ft. Kw.	Possible Max. Dem. Per 1,000 ft. Kw.
										1920
A	34		17	700 ft. No. 0	50	105.5 + 25	43.7	33.3	62.5	125
B	39	22	18	700 ft. No. 2	46	123 + 28.5	47	31.5	67	145
										1929
A	28	19	13	500 ft. No. 0	46.4	90 + 20	39	35.4	78	168
B	50	33	25	700 ft. No. 0	50	201 + 40	57.5	23.8	82.1	164.2
C	37	35	27	500 ft. No. 0	73	186 + 30	62.1	28.7	124.2	170.2
D	28	27	20	500 ft. No. 0	71	161 + 23	48.3	26.2	96.6	135.2
E	22	22	19	300 ft. No. 2	86.3	153 + 18	34.5	20	115	133
F	20	19	17	500 ft. No. 0	85	137 + 16	34.5	22.5	69	93.3
G	21	21	18	500 ft. No. 0	86	145 + 17	39	24	78	91
H	68	71	52	2000 ft. No. 0	76.4	419 + 54	149.5	31.6	74.75	116.25
I	28	28	28	300 ft. No. 0	100	225 + 23	46	18.5	180	360
J	160	151	125	1000 ft. No. 0	78	1006 +128	138	12.1	138	177
K	114	95	91	1000 ft. No. 0	80	733 + 91	115	13.9	115	164
L	56	44	22	700 ft. No. 0	39	177 + 45	48.3	21.7	69	175.5

FIG. 2

Typical Daily Load Curve
Test Section "C"
37 Customers 27 Ranges



range load, and I believe its possible maximum demand to be the greatest that could be obtained without considering apartment houses. Each customer lives in a flat of a duplex semi-detached building with ranges supplied by the landlord. That is about the limit in spacing for two-story buildings and also eliminates any question of gas cooking, etc. This section is only built on one side of the street so we can double the results obtained for its possible maximum demand. J and K are larger sections in the same district, including large groups of similar double duplex buildings, together with a number of small houses, some of which are not even wired for electric ranges. See Fig. 2 for typical load curve.

From this we see that the maximum demand to be expected in districts where many ranges are used, varies from approximately 60 kw. to at least 150 kw. per thousand feet of street, and this load may be, for purposes of calculation, considered as taking place for from two to three hours per day. Also, looking into the future we may consider a load density of 225 k.w. per thousand feet to be not impossible.

Now starting with 75 kw. per thousand feet, which is the load which can be conveniently carried by 2-25 kw. transformers and which was also the maximum demand found by Mr. Schwenger in his calculations of eight years ago, we can construct the following table, No. 2, to show what the annual carrying charges would be for both secondary lines and transformers, using various sizes of wire and different transformer spacings. Spacings of 800, 1,000 and 1,200 feet only are used in this case for the purpose of

TABLE NO 2.

ANNUAL CARRYING CHARGES PER 1000 FEET OF SECONDARY CIRCUIT LOAD—75 KW.

Size Wire	Wire Charges	Sec. Cu. Loss	Trans. Cu. Loss	Trans. Core Loss	Trans. Charges	Total Charges	Voltage Drop	Trans. Size
				800 ft. Transformer Spacing				
4	$15.64	$31.42	$11.25	$18.75	$121.25	$198.31	6.57	2 – 20 kw.
2	19.20	19.74	11.25	18.75	121.25	190.19	4.13	
0	32.89	12.42	11.25	18.75	121.25	196.56	2.6	
000	55.16	7.82	11.25	18.75	121.25	214.23	1.63	
0000	66.86	6.20	11.25	18.75	121.25	224.31	1.3	
				1000 ft. Transformer Spacing				
4	15.64	49.08	10.50	19.00	110.49	204.71	10.37	2 – 25 kw.
2	19.20	30.84	10.50	19.00	110.49	189.93	6.51	
0	32.89	19.40	10.50	19.00	110.49	192.28	4.1	
000	55.16	12.22	10.50	19.00	110.49	207.37	2.58	
0000	66.86	9.70	10.50	19.00	110.49	216.55	2.	
				1200 ft. Transformer Spacing				
4	15.64	70.68	10.41	20.00	102.83	219.56	14.8	2 – 30 kw.
2	19.20	44.40	10.41	20.00	102.83	196.84	9.3	
0	32.89	27.92	10.41	20.00	102.83	194.05	5.86	
000	55.16	17.58	10.41	20.00	102.83	205.98	3.69	
0000	66.86	13.96	10.41	20.00	102.83	214.08	2.93	

illustration, and energy loss has been calculated on the peak load for three hours daily. Spacings of 400 and 600 feet were also worked out and the results will be considered later. Nos. 4, 2, 0, 000 and 0000 have been taken as standard size conductors and the annual charges have been based on 10 per cent. of the labour and material costs of erection, and include interest, depreciation and sinking fund, etc. Similarly, annual charges on transformers are based on 13 per cent. of their value. Energy loss is taken as one cent per kilowatt-hour. Transformer core loss is shown but would not affect the calculations if omitted, as same is not dependent on load.

As mentioned, 50 kw. in transformer capacity is required to supply a load of 75 kw. per thousand feet and for best results 2–25 kw. transformers are used, hung on same pole and connected in series. Consequently for 800 ft. spacing, we would use 8/10 of 50 = 2–20 kw. transformers, and so on.

Examining this table we see that the lowest annual charge is $189.93 for No. 2 wire with transformers spaced 1,000 ft. apart. The voltage drop in this case is 6.51 or 5.66 per cent., so if we wish better regulation we must take the next lowest annual charge. This is $190.19 for No. 2 wire having 800 ft. transformer spacing, and a voltage drop of 4.13 at the end of the secondary line. This then is the most economical size and spacing to use. Experience, however, tells us that it is wise to provide for a future load density greater than present conditions necessitate. The next best annual charge is $192.28 for No. 0 wire with 1,000 ft. transformer spacing, and gives a slightly better voltage drop of 4.1. This transformer spacing and wire size has been our standard practice since 1921, when it was found to be the most economical combination for conditions at that time. Mr. Schwenger's calculations then were based on the use of the peak load for 1½ hours daily, as the average energy loss for a yearly period, while to-day I have taken three hours as a fair approximation. Therefore, if larger loads than 75 kw. are expected, it would seem as if installing No. 0 secondary copper and spacing transformers 800 ft. apart might not warrant the extra outlay of $4.28 yearly.

With this in mind, let us take the lowest or most economical figures out of a series of similar tables for different loads and using additional transformer spacings. The result is compiled in Table No. 3. This shows a series of annual carrying charges (to the nearest dollar only) of the most economical wire sizes for different maximum peak loads per thousand feet. The maximum voltage drop to be expected is also indicated.

Suppose we now take a more or less typical example at random to illustrate this idea. Let Fig. 3 represent a model City block with primaries on adjacent streets 800 ft. apart. Suppose we have a maximum demand of 112½ kw. per thousand feet on all four streets. Secondaries would be No. 0 for the most economical carrying charges and the voltage drop 3.91. The annual carrying charges for secondaries and transformers on all four streets would then be 8/10 of 261 x 4—$835.20 per year.

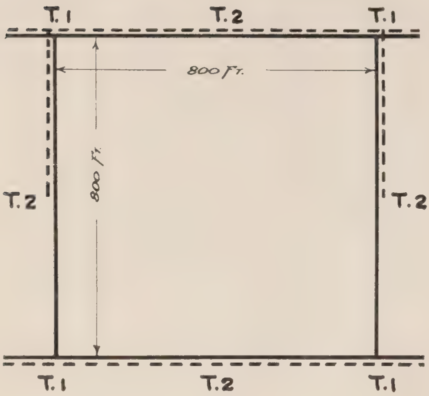
Compare this with annual cost of

TABLE NO. 3.

ANNUAL CARRYING CHARGES PER 1,000 FEET OF SECONDARY GIVING MOST ECONOMICAL WIRE SIZE.

56.25 kw. Size Drop	75 kw. Size Drop	112½ kw. Size Drop	150 kw. Size Drop	225 kw. Size Drop	Trans. Spacing
$193 4 1.23 2–7.5 kw.	$221 4 1.6 2–10 kw.	$284 2 1.54 2–15 kw.	$341 2 2 2–20 kw.	$451 0 1.94 2–30 kw.	400 ft.
168 2 1.74 2–11.25 kw.	200 2 2.32 2–15 kw.	260 2 3.48 2–22.5 kw.	339 0 2.92 2–30 kw.	456 000 2.74 2–45 kw.	600 ft.
157 2 3.1 2–15 kw.	190 2 4.13 2–20 kw.	261 0 3.91 2–30 kw.	333 0 5.2 2–40 kw.	462 0000 3.9 2–60 kw.	800 ft.
150 2 4.84 2–18.75 kw.	190 2 6.51 192 0 4.1 2–25 kw.	268 0 6.1 2–37.5 kw.	338 000 5.16 2–50 kw.	483 0000 6.1 2–75 kw.	1000 ft.
152 2 6.95 156 0 4.39 2–22.5 kw.	194 05.86 2–30 kw.	276 000 5.51 2–45 kw.	340 0000 5.86 2–60 kw.	0000 8.79 Drop too much	1200 ft.

Fig. 3



carrying same load on secondaries on each side of street. From table, half of the above load would require No. 2 wire at annual charge of $157.00 per 1,000 ft. or 8/10 of 157 x 4 x 2 equals $1,004.80 for all four streets, which is $169.60 per year more than for the single side proposition without taking into account the added cost of second side pole line. If load is now increased, what is the most economical means of supplying same? For easy figuring, suppose load may be doubled. If secondaries are changed to carry this increased demand, then from table, No. 0000 copper is required and annual charges would be 8/10 of 462 x 4=$1,478.40. If instead, streets are double sided with No. 0 secondaries, annual charges would be $835.20 x 2=$1,670.40 without considering additional pole lines.

Now instead, suppose we use same size secondary copper and cut transformer spacing in half. Of course, two new primary extensions will be required of 400 feet each. Carrying charges on these can be conservatively figured at $40.00 per 1,000 feet per annum, and therefore carrying charges of lines and transformers on all four streets now becomes 8/10 of 40 plus 8/10 of 451 x 4 equals 32 plus $1,443.20=$1,475.20 which is the lowest figure of the three methods proposed. This amount does not appear much better than that where the secondaries were changed to No. 0000 and the transformer spacing left at 800 ft., but it must be remembered that the actual cost of changing the secondary lines and replacing transformers has not been mentioned, whereas in the latter case the cost of primary extensions has been included and only the additional transformers of same size as original installations are required. Also the voltage drop will be lower.

Referring to test section "C" in Table No. 1. We obtained a maximum demand of 124 kw. per thousand feet using No. 0 secondaries with 1,000 ft. transformer spacing. From table No. 3, the closest load to this,—112½ kw. would have given us a voltage of 6.1 which is slightly over the allowable 5 per cent., so that with the larger load obtained by actual test, a voltage complaint would not have been unexpected. That is exactly what happened and we are now arranging to construct a one-wire primary line with a pair of transformers at the end to overcome this overloaded condition. Just as in the typical example worked out above, this was found to be the most economical procedure rather than changing secondary copper or installing double side secondary lines.

In test section D, we had a similar low voltage complaint several years ago, and having found that our secondary lines were overloaded and

not being so wise as we think we are now, we installed second side house lighting secondaries on a new concrete pole line. This, we have just shown, is more expensive than building a new primary extension or even changing existing secondary copper.

In obtaining values of core and copper losses of transformers in order to arrive at their total carrying charges, it became necessary to classify them into separate groups—those having comparatively high exciting currents, on an average of say 4.7 per cent., which we will call class A transformers,—and those having low exciting currents of approximately 1.7 per cent. These latter we will refer to as class B transformers. The purchase price of B transformers is taken as being 25 per cent. greater than class A. It then becomes interesting to note how the total carrying charges of the two types compare.

In Table No. 3, class B transformers were used and a separate and similar table was worked out using class A type. The difference in initial cost could not quite offset the lower charges for core and copper losses except in the case of large loads with large transformer spacing, which is, however, not an economical combination to use. However, in municipalities where penalties are charged for low power factor, we are able to add an increased charge to the class A transformers. In 1924, Mr. Schwenger, also before the summer convention of the Association, shows that "all reactive volt amperes in the load at power factors lower than 90 per cent. are paid for on a basis of approximately 50 per cent. of the prevailing power rate" and "thus for Toronto where prevailing rate is $32.00 per kilowatt per annum, we are able to valuate reactive kilovolt amperes causing penalty at $16.00 per reactive kv-a. per annum". Consequently in Table No. 4, we have a comparison between the annual carrying charges per 1,000 ft. of secondary using both A and B transformers, and also showing the penalty charge added in the case of A transformers due to the difference in exciting current.

The effect of increasing cost of copper secondaries was also looked into. In the previous tables, carrying charges on copper wire were figured at approximately .22 cents per pound. Similar tables were made up using a price of .35 cents. Little practical difference in the results was obtained. That is, the annual charges were, of course, somewhat higher, but in only a few cases were the economical size of secondaries affected.

Now what general conclusions can we draw from these investigations? From Table No. 3, we see that the most economical size secondary to use is No. 2 or No. 0 wire depending on the voltage drop we are allowed. No. 1 size might hit the spot better still if it had been considered.

The most economical size of transformer is apparently between 15 and 30 kw., considering them to be used in pairs. That is for secondary lines feeding one street only, but if transformers are installed at the intersection of two streets, and the load each way is assumed to be equal, then twice the capacity shown in this Table would be required.

As the load is increased the spacing of transformers is economically decreased even though new primary extensions have to be constructed. This also gives a reduced voltage drop.

TABLE NO. 4.

COMPARATIVE CARRYING CHARGES PER 1000 FEET OF SECONDARY USING CLASS A. OR B. TRANSFORMERS

Class	56.25 kw.	75 kw.	112.5 kw.	150 kw.	225 kw.	Trans. Spacing
A	174 + 18 = 192	198 + 24 = 222	264 + 36 = 300	321 + 48 = 369	435 + 72 = 507	400 ft.
B	193	221	284	341	451	
A	152 + 18 = 170	186 + 24 = 210	248 + 36 = 284	309 + 48 = 357	436 + 72 = 508	600 ft.
B	168	200	260	339	456	
A	147 + 18 = 165	180 + 24 = 204	245 + 36 = 281	318 + 48 = 366	452 + 72 = 524	800 ft.
B	157	190	261	333	462	
A	141 + 18 = 159	180 + 24 = 204	254 + 36 = 290	323 + 48 = 371	474 + 72 = 546	1000 ft.
B	150	190	268	338	483	
A	146 + 18 = 164	185 + 24 = 209	266 + 36 = 302	342 + 48 = 390		1200 ft.
B	152	194	276	340		

Modern Billing Methods

By H. L. Summerlee, Burroughs Adding Machine Co., Detroit, Michigan

(*Read before Association of Municipal Electrical Utilities at Bigwin Inn, Lake-of-Bays, Muskoka, July 5, 1929*)

THE application of mechanical aids to improve accounting systems has had an important part in conventions and conferences held by the various Public Utility Associations.

Committees without exception have expressed approval after carefully considering and studying systems using machines for billing. Many improvements have been made in the production and distribution of electric power which have been reactionary in making the executives feel the need of improved accounting methods, especially in that branch of office work generally referred to as customers' accounting.

As the engineer, the supervisor or the mechanic supplies the data on the physical equipment to the executive, the accountant performs a similar service on the financial conditions and operations. He must be as accurate in his work and statements as the man in charge of the planning, designing or operating of the physical elements of the works.

The accountant's work touches all the phases of the operation—investments, detailed cost of operation and distribution regulations and above all, the accounting relations between the customer and the utility. Certainly nothing affects the good-will of the customer toward the utility as much as accurate methods in keeping these accounts.

Generally speaking, the most fertile field for improvement is in the customers' accounting departments. This statement should not be construed as a reflection upon the supervision or personnel as the improvement is possible through the adoption of new accounting schemes, together with the most modern labor saving devices.

After applying adding machines to accounting work, mechanical engineers directed their efforts to make the machines better, more efficient and automatic to a greater extent. Now inexperienced labor may be quickly trained to do work that formerly could be trusted only to skilled bookkeepers, who no longer can be obtained at all times due to the increasing demand for accounting labor. This assistance is found in mechanical equipment, which reduces the mental and physical effort on the part of labor.

The general accounts of a utility, such as the balance sheet and other standard financial statements are similar in their structure to the general accounts of other lines of business. The subsidiary accounting, however, differs greatly; particularly that portion of the accounting between the utility and the customers. The number of customers, as compared with commercial enterprises and industrial establishments, is usually very large. With but few exceptions, every account is active at each billing period.

The utility accountant must give attention to the customers' records, which involve the application for service, reading of meters and rendering bills to assure accuracy in the revenue accounting. Many valuable leads for the merchandise sales department may be obtained at the time service is applied for by asking the applicant what appliances are to be used. To help eliminate the possibility of mis-spelling the customer's name or his address, the customer's name may be printed by hand on the application. By decreasing the complaints which might arise through erroneously addressing the bill or mis-spelling the name of the customer better public relations are maintained. The customer may be asked to verify the name and address shown on the application when the connect order is taken care of. The employee who installs the meter or turns on the service, should correct any errors of this nature.

Some utilities use a welcome letter to aid in confirming the recorded name and address of the customer. The welcome letter, with a verification post card which is to be returned, may be mailed to all new customers, when the verification post card is returned, it may be compared with the information shown on the customer's application.

The connect order form usually provides for such information as the location of the meter, the reading at the time the service is turned on, date, meter number, meter size and the name of the employee performing the work.

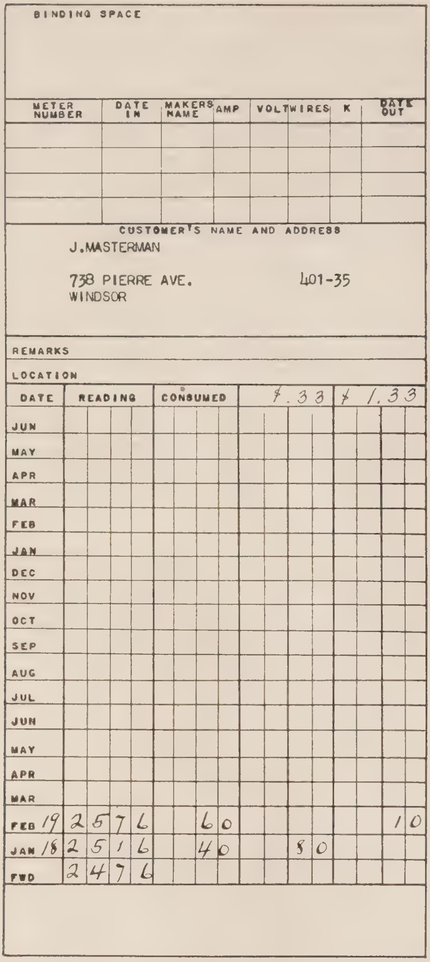
Meter records usually consist of meter record cards, meter test cards, meter connect, disconnect, and change orders, complaint tickets and meter reading sheets. These forms should be designed to serve the largest number of uses, eliminating if possible duplication of records. A meter reading sheet is maintained for each customer connected. The meter reading sheet and the connect order, when approved, are forwarded to the Accounting Department. The meter reading sheet is placed in the proper meter reading book and the connect order is filed in alphabetical sequence. It is customary to maintain the meter reading sheets in the same order that the meters are read. Each customer's individual account ledger should be assigned a folio number for identification in addition to the customer's name and should be filed at all times in the same order that the meter reading sheets are maintained. The folio may be based on the district, street and house number, for example, 2–10–122 denotes district No. 2, King Street (a number is assigned to each street) house number 122. A consecutive numbering system can be used by assigning a number to each customer. The folio number is all that need be shown on the cashier's coupon to enable the clerk posting credits to locate the ledger. When the ledgers are filed alphabetically, a sort is necessary to bring the ledgers and the meter reading sheets in the same order for billing purposes and another sort after the billing has been accomplished. It is much easier to keep an alphabetical index with cross reference to the folio numbers as an aid to locate an account when only the customer's name is known, than to re-arrange the filing before and after the billing period.

The meter reading routine should be scheduled to spread the work evenly through the period to provide the proper billing cycle. The average month consists of twenty-one working days. Therefore the entire schedule of continuous reading, billing and discount days should be based on that fact. This allows an even distribution of work throughout the month and also results in a more uniform collection of cash, preventing peak loads on the last discount dates. Each meter reading route consists of enough meter reading sheets to constitute a day's work. If domestic and commercial meters are included in the same route, the meter reading sheets may be of different colors to identify the service. The colors used should correspond to the colors of the bills and ledgers. For example, white for domestic service, blue for commercial service and buff for power. The variation of color acts as a signal to billers, tellers, sorters and posters.

The bills of a section of a district should be scheduled so that the last discount day will fall on the same day of the month each billing period. In case of this day falling on a Sunday or a holiday, the discount is allowed on the following day. This arrangement will tend to improve collections because if the bill is received regularly provision will be made to take care of the charges. The meter reading force in many utilities is under the supervision of the Accounting Department. While meter reading is not difficult, a short training period and written instructions will result in a saving. The meter should be understood so that the reader may answer questions asked by the customers. Some meters register a fraction of the current used making it necessary to multiply the difference between the readings by a constant figure to determine the actual consumption. These meters should be carefully checked to prevent a loss of revenue. Untrained men may make errors in the readings which are transcribed to the billing of the service to the customer. These errors result in complaints and added clerical work. Steps taken to eliminate these errors are of mutual benefit to the utility and the customers. An incompetent meter reader forms a weak link in the important operation of accurate handling of customer's accounts.

The meter reading sheet illustrated has many advantages. A continuous record permits checkings for high and low readings. Starting at the bottom of the form facilitates subtraction to determine the consumption as the larger number is above the smaller number. The bottom of the form is the most liable to become soiled from handling and should therefore be used first. Printing the months on the form provides a check on skipped readings, warning the Accounting Department to protect the service charge of two or more billing periods as well as the consumption charge at the first rate. Provision has been made at the top of the form for meter and customer data. It is important not to overlook such information as "key at 917 King Street", "Bad dog", and so forth because occasionally it is necessary, due to illness of the regular reader, to substitute a reader who is not familiar with the route.

The two right-hand columns are



BINDING SPACE

METER NUMBER	DATE IN	MAKERS NAME	AMP	VOLT	WIRES	K	DATE OUT

CUSTOMER'S NAME AND ADDRESS

J. MASTERMAN

738 PIERRE AVE. 401-35

WINDSOR

REMARKS

LOCATION

DATE	READING	CONSUMED	$.33	$1.33
JUN				
MAY				
APR				
MAR				
FEB				
JAN				
DEC				
NOV				
OCT				
SEP				
AUG				
JUL				
JUN				
MAY				
APR				
MAR				
FEB 19	2576	60		10
JAN 18	2516	40	80	
FWD	2476			

Meter Reading Sheet

used to enter the consumption charges. The service charge of each customer remains constant until the class of service is changed. The service charge is shown at the top of the column for the consumption charge at the first rate and the total of the consumption charge at the first rate plus the service charge is shown at the top of the column for the consumption charge at the second rate. Take for example, a customer with a service charge of 33c. billed on a rate schedule of the first 50 kw-hr. at 2c. and over 50 kw-hr. at 1c. If the consumption was found to be 40 kw-hr., 80c. would be entered in the column for the consumption charge at the first rate. The gross amount is easily arrived at by simply adding 80c. and 33c. If the consumption exceeded 50 kw-hr. for example, 60 kw-hr., 10c. would be entered in the column for the consumption charge at the second rate. The constant figure at the top of this column is $1.33 built up of 50 kw-hr. at 2c., plus the service charge of 33c. The gross amount in this example is computed by adding 10c. to $1.33. A chart may be used to good advantage in computing consumption charges when rates with fractional cents are employed.

It is to the advantage of utilities to keep abreast of the times with the latest developments in mechanical equipment. Addressing machine equipment plays an important part in an up-to-date office. Much time is saved in addressing meter reading sheets, customers' bills and customers' ledger records. After the plate has been made and checked, accuracy is assured. When forms are addressed by hand there is always a possibility of transposing the house number and folio figures as well as mis-spelling names. Printed information is uniform and easily read. Information such as meter reading dates, discount dates, etc., may be printed on the customer's bill with a minimum of time and effort. Employees' time records, pay checks and other forms may also be addressed mechanically.

Promptness in billing, good appear-

ance, legibility of bills and accuracy in accounting can be secured by the use of the proper mechanical devices.

Due thought and careful consideration should be given to the appearance, accuracy and neatness of the customer's bill, as the bill really maintains the contact between the customer and the utility. If merchandise is sold, the back of the bill may be used to bring this fact to the attention of the customer. This is a very good means of advertising as the bill will receive more careful attention than is usually given to advertising material. It is advisable to show the various rates to assist in checking the bill. If payment may be made at sub-office, banks or collection agencies, the addresses of these places should be shown. The information which appears on the bill should enable the customer to check the accuracy of the amount billed.

The two most common forms are the post card and the coupon bill. The post card bills are greatly in the minority, due to the rigid limitations in size, making it necessary to condense the information due to the customer. The public scrutiny that may be given to a customer's bill is also a serious objection to the post card bill. The coupon bill which most utilities are now using, has a coupon attached, which is returned with the payment of the bill. The customer is given the bill proper as a receipt showing the meter readings, consumption and detail of the charges. The coupon which shows the charge is retained by the teller receiving the payment. At the close of the day, the total of the amounts shown on the coupons should balance with the cash collected.

There are three plans of customers' accounting now in general use. The Stub Plan uses an individual monthly ledger. The Register Sheet Plan provides a multiple monthly ledger. The Individual Account Ledger Sheet Plan furnishes a continuous record of each customer's account, which overcomes the disadvantages of the Stub Plan and the inflexibility of the Register Sheet Plan. Some of the advantages of the individual account ledger sheet plan which may be mentioned are :

A continuous history of all transactions with the customer can be maintained, thus making available information often required by the Credit, Collection and other departments.

When an account is closed, the ledger may be transferred to a pending file until the final bill is paid, permitting close supervision of these accounts. The ledger is transferred to a permanent file when the final bill is paid.

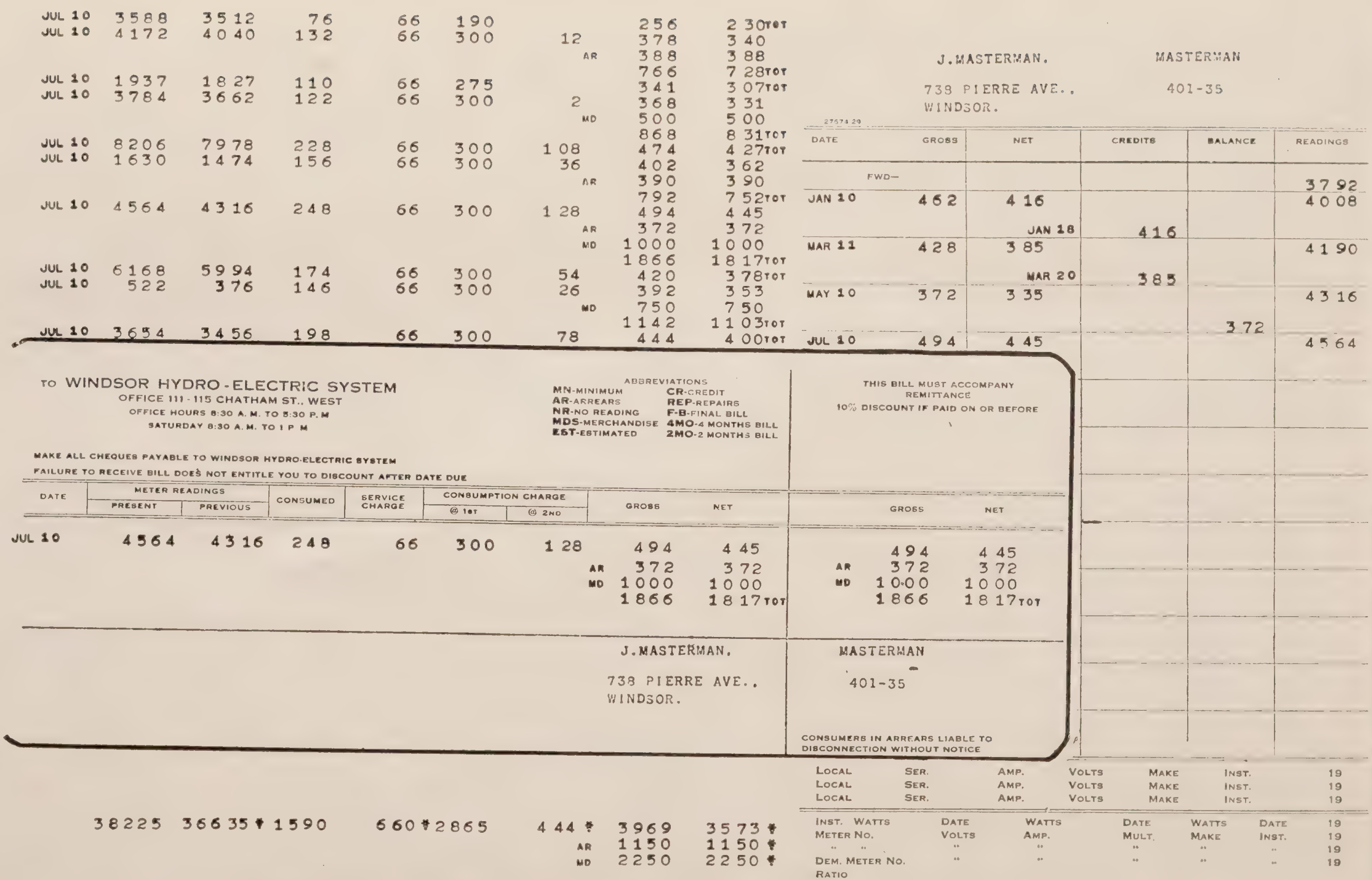
The individual ledger is an excellent record to show to a customer. The information is compact and data as to his neighbors accounts does not appear before him.

As new accounts are opened, the ledger may be filed in the proper sequence.

Space may be provided for special information, valuable to the billing and posting departments.

Balances are carried forward and a trial balance obtained at less cost than with the multiple monthly ledger.

With the use of a billing machine, the customer's bill, cashier's coupon,



DATE	PRESENT	PREVIOUS	CONSUMED	SERVICE CHARGE	@ 1ST	@ 2ND		GROSS	NET
JUL 10	3588	3512	76	66	190			256	230 TOT
JUL 10	4172	4040	132	66	300	12		378	340
							AR	388	388
								766	728 TOT
JUL 10	1937	1827	110	66	275			341	307 TOT
JUL 10	3784	3662	122	66	300	2		368	331
							MD	500	500
								868	831 TOT
JUL 10	8206	7978	228	66	300	108		474	427 TOT
JUL 10	1630	1474	156	66	300	36		402	362
							AR	390	390
								792	752 TOT
JUL 10	4564	4316	248	66	300	128		494	445
							AR	372	372
							MD	1000	1000
								1866	1817 TOT
JUL 10	6168	5994	174	66	300	54		420	378 TOT
JUL 10	522	376	146	66	300	26		392	353
							MD	750	750
								1142	1103 TOT
JUL 10	3654	3456	198	66	300	78		444	400 TOT

J.MASTERMAN. MASTERMAN

738 PIERRE AVE., 401-35

WINDSOR.

27574 29

DATE	GROSS	NET	CREDITS	BALANCE	READINGS
FWD—					3792
JAN 10	462	416			4008
		JAN 18	416		
MAR 11	428	385			4190
		MAR 20	385		
MAY 10	372	335			4316
				372	
JUL 10	494	445			4564

TO WINDSOR HYDRO-ELECTRIC SYSTEM
OFFICE 111-115 CHATHAM ST., WEST
OFFICE HOURS 8:30 A. M. TO 5:30 P. M
SATURDAY 8:30 A. M. TO 1 P M

ABBREVIATIONS
MN-MINIMUM CR-CREDIT
AR-ARREARS REP-REPAIRS
NR-NO READING F-B-FINAL BILL
MDS-MERCHANDISE 4MO-4 MONTHS BILL
EST-ESTIMATED 2MO-2 MONTHS BILL

THIS BILL MUST ACCOMPANY REMITTANCE
10% DISCOUNT IF PAID ON OR BEFORE

MAKE ALL CHEQUES PAYABLE TO WINDSOR HYDRO-ELECTRIC SYSTEM
FAILURE TO RECEIVE BILL DOES NOT ENTITLE YOU TO DISCOUNT AFTER DATE DUE

DATE	METER READINGS PRESENT	PREVIOUS	CONSUMED	SERVICE CHARGE	CONSUMPTION CHARGE @ 1ST	@ 2ND		GROSS	NET		GROSS	NET
JUL 10	4564	4316	248	66	300	128		494	445		494	445
							AR	372	372	AR	372	372
							MD	1000	1000	MD	1000	1000
								1866	1817 TOT		1866	1817 TOT

J.MASTERMAN.
738 PIERRE AVE.,
WINDSOR.

MASTERMAN
401-35

CONSUMERS IN ARREARS LIABLE TO DISCONNECTION WITHOUT NOTICE

LOCAL	SER.	AMP.	VOLTS	MAKE	INST.	19
LOCAL	SER.	AMP.	VOLTS	MAKE	INST.	19
LOCAL	SER.	AMP.	VOLTS	MAKE	INST.	19

INST. WATTS METER NO.	DATE VOLTS	WATTS AMP.	DATE MULT.	WATTS MAKE	DATE INST.	19
" "	"	"	"	"	"	19
DEM. METER NO. RATIO	"	"	"	"	"	19

38225	36635*	1590	660*	2865	444*		3969	3573*
						AR	1150	1150*
						MD	2250	2250*

Customer's bill, cashier's coupon, ledger record and recapitulation sheet made in one operation

ledger record and recapitulation sheet may be made in one operation, which saves a considerable amount of clerical labor. Various other commodities, such as water and gas, may be billed on the same bill for the electric charge. Arrears and merchandise may also be posted before the bill is removed from the billing machine. The forms illustrated were picked from one of a number of the utilities purchasing power from the Hydro-Electric Power Commission, who are now using billing machines.

All of the information necessary to enable a customer to check the accuracy of the charges is shown on the bill in the proper sequence. The consumption plus the previous reading equals the present reading. The service charge added to the consumption charges at the first and second rates will equal the gross charge. This complete information tends to maintain confidence between the customers and the utility.

Billing machines have many automatic feaures, for example : The meter readings are set up on the machine but once and, due to a repeat print mechanism, are printed on both the ledger and the customer's bill. This is also true of the gross and net charges which are printed on the customer's bill, cashier's coupon and ledger record. By mechanically repeat printing items from one form to the other, it is no longer necessary to compare the completed bill with the ledger. Automatic carriage tabulation and automatic printing of ciphers simplify the operation. The forms are dropped to the correct printing position without being aligned by the operator. The meter reading date may be printed automatically. Characters to identify class of service, miscellaneous charges and special bills can be used. Individual bills of two or more lines are totalled by the depression of a key. The carriage may be opened automatically facilitating the removal and insertion of forms. The labor saving devices on a billing machine permits bills to be prepared with both accuracy and speed with a minimum of effort on the part of the operator.

In addition to printing, the figures are accumulated to provide a complete proof of the billing. A batch of 75 or more bills are proved in the same manner that a customer would check the accuracy of his individual bill. The total consumption is added to the total previous readings, balancing to the total of the present readings. This assures that the readings and consumption of each bill are in balance with the meter book.

The consumption charges at the first and second rates may be converted into kilowatt hours and balanced to the total consumption. The total of the service charges added to the total of the consumption charges at the first and second rates is balanced to the gross charges. 90 per cent. of the gross charges should equal the total of the net charges. Thus a perfect check of all the billing data is accomplished. The total consumption and revenue have been accumulated, eliminating the necessity of adding these factors at a separate operation for statistical purposes. The revenue thus proved is added to the control ledger as the current debit.

Some utilities take the gross revenue into their Account Receiv-

able and others the net revenue. On an average, approximately 85 per cent. of the bills are paid net. If the gross is set up in the Accounts Receivable, it follows that the discount on 85 per cent. of the bills must be deducted from the Accounts Receivable. To accomplish this, the discount as well as the payment must be posted to the ledger, the total discount being charged to revenue and the total of the net amounts being charged to cash. After the discount period, only one posting is necessary and that is the amount of the gross bill which is charged to cash, affecting the balance or 15 per cent. of the accounts. When the net revenue is charged to Accounts Receivable, the above operations are reversed. The net only is posted to 85 per cent. of the accounts. After the discount period, the difference between the gross and net charges of the uncollected accounts is added to Accounts Receivable and the gross charges extended to the balance column on 15 per cent. of the individual ledgers. This is done at the time the delinquent list is prepared. Taking the net revenue into Accounts Receivable gives a truer financial condition.

The posting of the cash collected is very important. A cash return should be received for every bill sent out. Each one of these payments must be audited, posted as a credit to the proper account, and distributed to the control ledger in which the individual ledger is located.

Payments are received by mail, by payment to teller at the central office, sub-office, collection agency or by payment to collectors. Regardless of the medium through which the payment was received, collections made by each teller must be verified with the cashier's coupons which are forwarded to the Accounting Department for posting of cash. This verification may be accomplished by listing and adding the cashier's coupons or a distribution by districts or sections may be made by writing a cash book showing the customer's folio number with the amount of cash. An adding machine can be used to a good advantage on this work. After an audit has been made to verify that the cashier has turned in the correct amount of cash to correspond with the coupons, the collection must be posted to the individual ledgers.

The ledgers should be posted directly from the cashier's coupons. When a distribution is made by districts, the coupons are in the correct order for posting. Care should be exercised to make certain that the gross amount has been protected on bills showing a discount date which has expired.

There are several methods of posting cash to the individual ledgers and reconciling the total cash receipts to the control ledger. The rubber stamp plan has found favor with some utilities. The date of the payment is stamped opposite the debit, indicating that the credit offsets the debit. The control ledger is then arbitrarily credited with the amount of the day's receipts. The correctness of the posting is verified at the time the trial balance is taken. Considerable work is involved if an error is made during the period.

Credits may be posted directly to the individual ledgers with the billing

machine, accumulating the total of the posting to balance daily with the cashier's receipts. The machine method is of course more accurate and facilitates daily balancing of credit postings.

It is advisable to balance districts as billed rather than balance the accounts of the utility as a whole. This will permit posting arrears to the current bill. The arrears posted should balance with the previous month's uncollected balance. Balancing by districts one day prior to billing brings the arrears to the lowest point, as the bills of the previous period have been in the hands of the customer for a sufficient length of time to permit the Collection Department to take action on the delinquent accounts. Tabs placed on the delinquent ledgers are a great aid to the Collection and Billing Departments. A ledger that is tabbed denotes an unpaid balance signalling the biller that arrears should be posted with the current charge. The tabs are attached to the ledgers at the time the delinquent list is prepared for the Collection Department, after the discount period has expired.

The practice of obtaining a trial balance on all of the accounts at the end of the month is a very big task, regardless of whether or not machines are used, and it results in a large number of items being carried forward which are not due or payable on account of the bills being issued during the last half of the month. This peak load may be eliminated by balancing each district as a unit. Instead of doing all the work in a few days at the end of the month, it is spread out over the month.

Each district is in turn divided into sections, each section comprising approximately 750 customers. A control ledger is maintained for each section, showing the previous month's uncollected balance, the current debit, current credit and the amount outstanding. The unpaid amounts as obtained by this trial balance should all be transcribed to the current month's bills and the total of arrears billed, balanced with the control. This method tends to localize errors and speeds up delivery of the bills, as each section of a district may be balanced as billed and need not be held up until the entire district is balanced.

The control figures of each section are reflected in the control ledger of the district. Miscellaneous adjustments are posted to a journal daily and transferred each month in total to the district control ledger as a journal entry. These progressive trial balances are reconciled with the controls for the various ledgers and the regular month-end trial balance for the general ledgers is obtained from the controls. These progressive trial balances, while secured every thirty days just as they are under the month-end balancing arrangement, are not reconciled in total against the general ledger. They are reconciled section by section against the ledger control which in turn is reflected in the general ledger.

This cycle balancing method makes it possible to get a correct view of the condition of the collections. The balance on any one control as of the billing date, which is the lowest point of the month, may be compared with the corresponding balances out-

standing on the other controls for various sections, and also shows how collections are running in each district.

The month-end trial balancing method merely gives a view of the entire utility and includes many items not yet due.

To summarize, the billing machine offers neatness, legibility and accuracy of bills, assurance that all customers have been billed correctly, and daily proof of accounts receivable, cash receipts and statistical reports. Machines may also be applied to cash book writing, labor and material accounting, merchandise records and various other accounting problems encountered in a utility.

Lesson from Experience

Within the past few days one of our linemen fell from a pole. Fortunately he was not seriously injured.

His pole belt broke. He was wearing a new standard H.E.P.C. belt, which was about seven months old. An examination showed the leather in the pole strap to be in apparently perfect condition except at the point of fracture. The break occurred where the pole strap is looped through the snap. At this point for about 1½ in. the leather was extremely hard. A cross section showed it to be black and it looked like hard glue. This was caused by the belt having been hung up with the snap in contact with heat. When hanging up belts keep them away from heat. The snap became so hot that it ruined the leather. Never dry damp or wet leather with the aid of heat. Such treatment weakens the fibre of the leather and may even destroy t as above.

After exposure to water, wipe off the belts and go over the leather carefully with a rag dipped in neatsfoot oil. Work the oil well into the leather. The oil will go into the fibres of the leather as the water evaporates. Hang the belts up to dry and do not place them near heat. Remember that at a temperature slightly above the temperature of your body, the leather becomes "glutenated," brittle and easily cracks.

"*Examine Your Climbing Equipment Every Day.*"

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Association of Municipal Electrical Utilities

Report of Rates Committee

GENTLEMEN :

The Rates Committee for 1929 have held one meeting since their appointment in January last. This meeting was held in the Hydro-Electric Power Commission's Offices on April 18th with sixteen members in attendance as well as representatives from the Hydro-Electric Power Commission of Ontario.

The meeting was called at Mr. Jeffery's request to consider a proposed change in the Commercial Lighting Rate. This was brought about due to the Commercial consumers using their load for longer periods and at present rates being forced to pay a considerably higher bill than they would if billed on power rates. In short, it was deemed advisable to give some further consideration to the long hour users as compared to the short hour user whose demand resembles that of the Domestic consumer.

After a lengthy discussion a motion was carried unanimously whereby your Committee endorsed the proposed revision in the follow-up rate for Commercial Lighting Service, the actual figure to lie between the second domestic rate and the final power rate dependent upon conditions in each municipality.

The Committee next discussed the question of whether or not demand meters should be installed on Commercial Lighting services free of charge to the consumer or on a rental basis. The result of this discussion was a motion whereby your Committee endorsed the principle of installing demand meters on Commercial Lighting Services without charge to the consumer. The motion carried with one member dissenting.

A communication was received from a municipality requesting that the Committee consider the removal of the service charge on the Domestic Lighting Rate and the number of Kilowatt-Hours at the first rate be increased so as to avoid any shrinkage in revenue. The argument advanced was that it was extremely difficult to give the public a logical reason for the present service charge. After considerable discussion it was agreed that it is quite likely that demand meters will be required on the larger domestic services in the near future and under such conditions it would be necessary to retain the present form of rate.

One member brought up the question of class discounts on power rates, maintaining that these and the restricted hours now in use were becoming obsolete. A sub-committee with Mr. E. I. Sifton as convenor was named to go into the matter and report.

Yours obediently,

RATES COMMITTEE A.M.E.U.

J. W. PEART,
Chairman.

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Relations of Local Commissioners

By W. G. Hanna, Legal Department, H.E.P.C. of Ont.

(*Address to Association of Municipal Electrical Utilities at Bigwin Inn, Lake-of-Bays, Muskoka, July 5, 1929.*)

THE man who gave the title to this paper was an Irishman. He called it the "duties" of Commissioners. I think what he really meant was the "relations" of Commissioners. He must have been taking his relations as a duty. Some people seem to fear that the subject was a little delicate—coming here to tell the Commissioners what their duties are. Even when it is changed over to the "Relations of Commissioner", it is still a delicate subject, because relations are always delicate.

There are a number of relations that the Commission is involved in which are interesting. The one to start with, from our point of view, is, of course, the relation between the Local Commission and the Provincial Commission.

Then there is the interrelation—which is a little closer home to you, gentlemen—that is, the relation to the Commissioners themselves, the kind of an institution you are in the eyes of the law, and how the business should be conducted. The Statute says the Local Commission is a body corporate, consisting of three or five members. That constitutes you a Corporation just the same as any Joint Stock Company, with this one distinction, that with the Joint Stock Company you have many shareholders who have a right to vote and other interests, and the whole body constitute the body corporate. In this case, the shareholders are the electors of the municipality for voting purposes, but the ones who share in the dividends and profits are those who consume the electricity through you ; so the analogy is not complete. You constitute the Board of Directors and are incorporated as a body corporate. Thus the relation of the

CONTENTS

Vol. XVI No. 8

August, 1929

	Page
Relations of Local Commissioners	269
Merchandising Electric Refrigerators - - - - - -	282
The Prevention of Accidents - -	292
Pension and Insurance Plan - -	294
A.M.E.U. Report - - - -	301

Commissioners to themselves is an interesting one from the local standpoint.

Then there is the relation between the Local Commission and the Municipal Council, which may be hard to define fully. Nevertheless, some points in that relation may prove interesting. There are also the relations between the Commission and its customers ; and there is a further one, the relation between the Commission and the public, for such matters as public liability.

In regard to the first relation between the Local Commission and the Provincial Commission. From what little experience has drifted through to me, I think I would be in order to congratulate every Local Commission upon its spirit of co-operation and the attitute the Commissioners have assumed toward the Provincial Commission, seeking to avail themselves of the experience and the information that can be had there. It is some times of great value for a Local Commissioner to reach a central body, which is gathering information from all over the Province. It is not only in their own best interests, but, as I hope to show, it is in the best interests of the institution as a whole. If you follow the business trend, for instance, in merchandising to-day, you will notice that the old game is done. The individual who plays his own lone hand and does it in his own way, and has his own secret method of doing business, is not, on the average, standing up against competition. He knows his own business but no one else knows of it. The man who wins out is the man who belongs loyally to his Trade Association, contributes his information to it, and on every possible occasion gets out of it all the information he can. These Trade Associations are very useful bodies, because they gather complete data on costs of production, methods of sales, of prices, and everything touching that trade. Every member of the Association is privileged to get the benefit of all that information, and some times also to get the strength of the whole Association behind him when he has a real battle on his own hands. That is the business trend in other lines, and the Utility business cannot escape.

There is another reason. The Utility business is necessarily a monopoly. At one time, in London, the idea of competition was so firmly grounded in the minds of the people that they thought the only reasonable way in which they could secure proper rates was to establish a large number of small Power Companies competing with one another. They have since learned how extremely costly a business that was, and are coming now to accept gladly the other point of view that the reasonable way of handling the problem is to give one

authority complete jurisdiction within its district and then to control with advice and regulation. We find, in the States, that Utilities are strictly controlled. A rather strange situation has developed. Before the war, Utilities and Railways fought for their franchises and consistently maintained in the Courts that these franchises were sacred contracts which could not be touched. After the war, prices and conditions had changed so completely that these sacred contracts were no longer any protection. The Companies were very glad to avail themselves of the State Commissions to surrender their franchises, take a permit and have the State Commission take charge of their rates. That is a very thorough going business in the States, because State Commissions send their own Accountants in, take a complete inventory, set their own valuation, prescribe their own returns and on that basis determine the rate. Sometimes individual Companies have felt that they have suffered a grievance and have applied to the Courts, but with little success. The tendency is continually towards establishing the power of the State Commissions, because, after all, it is a public business and the public must be served.

With this little preliminary canter over what is being done in other places, you will get a little clearer view of the relation of the Local Utility to the Central Commission. The Central Commission has available important technical information, trained technical advisers in engineering, in accounting and in business administration. It has a large and wide experience, because it can draw on all the Utilities in the Province of Ontario and has facilities for getting the necessary information from outside of Canada. I only mention these things by way of putting before you again what you, no doubt, know, namely the facilities for service that can be obtained through your Trade Association. The local Commission may have a problem that it thinks is entirely individual. In their circumstances they cannot see anything else; but experience has shown that that is not a singular problem, that there are principles involved which have appeared in other cases. By the application of these principles, the problem in this particular instance can be successfully solved. I think that a great many cases of individual difficulty could be very easily approached from that angle. While you are familiar with the particular facts—and they are to you the most prominent feature of the problem—there are underlying principles that are not so clearly seen. The local circumstances loom large and obscure the real issues. There are times when abstract distances enable one to arrive at a clearer understanding of what is really in the problem.

Next, let us turn to the relation of the Commissioners to themselves as a corporate body. There is one recommendation I would like to stress very strongly. When the Statute says that the Commission is a corporate body, it means exactly what it says; that the Commission is a Corporation, and when a Corporation makes a bargain, the only way it can speak is by its Corporate Seal. If you are making a contract, that

contract must be executed under the Corporate Seal and attested by the signatures of the proper Officers, duly authorized.

The next point in the conduct of your business is the necessity for a regular procedure in conducting meetings and general business, especially when important transactions are being put through in order to see that they are put through in the regular manner by resolution or by by-law. I would like to recommend, for your consideration, the advisability of preparing a brief code of procedure—not as extensive as Town Councils have—but nevertheless a brief code of procedure for the conducting of meetings and general business. It will keep a regularity in your proceedings that will help you in sometimes unscrambling records and transactions afterwards.

I pointed out a short time ago that this Corporate body consists of three or five members who are really Directors, and that the shareholders entitled to dividends are the consumers. Other functions of the shareholders are performed, not by the consumers, but by the electors of the municipality. One Commissioner—of course, this is a point with which you are very familiar—is, *ex-officio*, the head of the Council, and the rest are elected. The point is that, in their election, you are governed by the parts of the Municipal Act relating to elections of Councillors. The Statute on that point is very specific. It says that Parts 2, 3 and 4 of the Municipal Act—which are applicable to members of the Council of a local municipality—shall apply with appropriate changes to the Commissioners to be elected. There is one illustration that would be worth while considering for a moment. An election was being held—three on the Commission—one for election. Two men were nominated. It turned out that the one who was elected was a member of the School Board. This question was raised after the election, and the conclusion reached locally was that his resignation was the easiest way out of that difficulty. He was a considerate man, and he resigned. All thought that ended it, and that the other man automatically stepped into his place. There were local reasons that didn't make that convenient—but I need not go into them. Apart from that it was a complete mistake in procedure. The member of the School Board was never properly qualified to be nominated. Therefore, there was no proper election. The election was carried through on a misconception, and the Statute provides that, under circumstances of that sort, the Council must prepare for another election immediately. That ultimately had to be done. I can recommend this with full confidence to you, gentlemen, because it was the advice of the lawyer whom that municipality consulted in a neighboring town. He interpreted the Municipal Act in that manner, and he is thoroughly capable on the subject.

There is another point of view for considering the qualifications of candidates for the office of Commissioner, namely the point of view of business capacity. I have a whole list of qualifications from that point of view. They should be competent

engineers, should be capable operators, able contractors, good buyers, forceful salesmen, judicious advertising men, good accountants and financiers, and also capable in public relations. I hope you won't take this too seriously. By all that, I mean that the Commissioners should have some capacity to understand all these different features which vitally affect their work.

It would be impossible for any one man to excel in all these fields ; but the capable businessman elected to a Commission should know something about them. He should know the business that comes before him and its difficulties ; he should know when to give the staff their head. He should know when to shut down on public criticism and be able to defend the Commission's policies in such a reasonable way as to convince the public that the Commission is correct. I have a particular reason for putting that forward. It seems to me there is a certain interest attached to it. A man takes a position as a Commissioner, and it isn't a sinecure ; it isn't just simply a matter of honour in the community—of course, it is a matter of honour, but there is real business attached to it. The Commissioner who becomes interested in that work finds it absorbing. If you compare the nature of the business with other businesses in the community, and the values attached to it, you will see that it is one of the most important types of business in the community. Take alone the investment in dollars. I won't attempt to quote figures, but you can apply your own. If you were stockholders in a business having that capital invested, what type of man would you want to have as Manager. If you were undertaking the work of management, what business acumen and business interest would you want to apply. I think it is an interesting field, because I know there are a great many Commissioners who have found it so.

There is one minor point—I don't know whether it is worth bringing it up here—but I will just mention it in passing. There is a peculiar turn in the Municipal Act that does not apply to the Commission. In the Municipal Act, servants hold their positions at the pleasure of the Council, and there are cases which have established that a Council can dismiss the employee without necessarily stating a reason for doing so, although the Judges have gone so far as to say that they should be prepared to satisfy the conscience of the Court. Now, do not be misled. That does not apply to Local Commissioners. They are in the position of ordinary employers and must be governed by the law relating to employment in ordinary business.

Next comes the relation between the Commissioners and the Municipal Council. From the Statute, it is one of some difficulty, though easy enough to recite. The Statute first provides that the control and management may be entrusted to a Commission. Then, in Section 36, it provides that, "Upon the election of the Commissioners as hereinafter provided, all the powers, rights, authorities and privilges which are by this Act conferred on the Corporation shall, while such by-law remains in force, be exercised by the Commission and not by the Council of the Corporation."

This is the form the Statute took in 1912, and it has been unchanged ever since. Prior to that, it was rather a statement of a transfer of powers from the Council to the Commission ; but difficulties had arisen, and it was stated clearly in 1912. When the Commissioners are elected, all the powers, rights, authorities and privilges by the Act conferred on the Corporation shall be exercised by the Commission and not by the Council. Now, how far does a Commission displace the Council? They certainly have control and management, without a doubt, and the Council cannot interfere with the management of the Commission or its control of the Utility. In relation to ownership there is some question. Very little question has arisen about the ownership of the equipment ; but in some places, a question has arisen about ownership of the land. The Act has never expressly stated the position in relation to ownership of land. In a great many places, a deed is taken in the name of the municipality and in some places in the name of the Commission. There is considerable variation. I cannot state the real solution too positively because there are no decided cases on the issue, but it seems to me that the reasonable line is something like this. The Commission, as a body corporate, has the conduct of the Utility business, the Council has nothing to do with it. If you are buying land, it may be convenient, for your own purposes, to take that in the Commission's name, because, under the Statute, you are a body corporate and entitled to hold land for the purposes of your Utility. On the other hand, it may be convenient to take that land in the name of the municipality. I am not prepared to draw any line between those two positions, but here is the point. If that land is taken in the name of the municipality, it is still ear-marked and belongs to the local Utility, and not subject to the control and management of the Council. When you come to sell the land, the Council has not the say as to whether you should sell it or not, or how you sell it, or what price you should sell it at. You have to use your best business judgment on that issue. Because the land may be in the name of the municipality, you will have to furnish a deed signed by the Mayor and Clerk or the proper Officers, as the case may be, and under the seal of the municipality, but they are only officials of the Corporation to do that duty, when you are performing your duty under the Statute. I think that is the reasonable line to follow. As I said, there are no decided cases, because none have been brought to Court on that issue.

One of the reasons I am putting forward that opinion so strongly is an analogous case in the Township of York. Certain duties under the Assessment Act had to be performed by the Treasurer of the Township. Through some mishap in the proceedings, something was not carried out which the Statute required, and an attempt was made to upset the proceedings. The Township of York was sued. The Judge held that the Treasurer was, in that instance, under the Assessment Act, a person named by the Statute, that because of his office, they had fixed on this person who was appointed Treasurer of the

municipality and had said, "We will take him to use for our Statute, the Assessment Act, and he will do these things under the Assessment Act." The Township was not liable and the Treasurer was personally liable. Now, if you will carry that analogy over, you will see that the Commission is what they call in law Latin *persona designata*, a named person, to perform the Utility business for the municipality, and the local Utility is the one that assumes the responsibility, and not the Council. Similarly, the Mayor and the Clerk, like the Treasurer mentioned above, are named persons. Therefore, the Mayor and Clerk are the signing Officers for the purpose of the Utility, when necessary.

There is another matter which really should have come before this last point. It is in respect to the handling of money. The case is an old one, and I had occasion to refer to it once before. The local Treasurer, through his Scotch upbringing, decided that he ought to supervise all the vouchers before he would allow any money to be paid at the requisition of the local Utility. That is past history now and hardly anyone would think of attempting it. Just in case one might, there is one sure and easy remedy for the Utility, that is to appoint its own Treasurer. The Statute provides that the Officers and employees of the Corporation shall be continued until removed by the Commission, unless their engagement terminates sooner. Your solution would be to appoint yourself Treasurer immediately, requisition the Corporation for your moneys, open your own bank account, and put them in that account, and they are your moneys.

There is one string on this control and management that you are all familiar with, that is that nothing in the Section shall divest the Council of its authority with reference to raising the moneys. That was not put in there for the purpose of putting a limitation on the Utility, but simply to prevent duplication of the machinery. The Council, under the Municipal Act, has the machinery for raising money by borrowing on Debentures and by taxation, and there is no sense in duplicating that machinery in the same municipality, so the Council has to raise the money. On the other hand, the Act says that the Treasurer of the Municipality shall upon the certificate of the Commission, pay out any money so provided. Your case is quite analogous to the School Board. The Public School Act, Section 57, has exactly the same provision. There is a recent case, arising out of the Home Bank—Clarkson *vs.* the Town of Alliston—that throws some very interesting light on that precise point. Mr. Boys, of Barrie, quite a well known lawyer, argued that the moneys deposited by the Town of Alliston in the Home Bank were moneys of the Corporation and not moneys of the School Board. He limited his argument to the unexpended balance of debentures issued at the instance of the School Board. The School Board had asked for so much Debentures. The Debentures were sold. The money was in the bank under the name of the Town, and the Board simply had not drawn it out. He said while it remained in

the bank in the name of the Town on Debentures of the Town, that money belonged to the Town. The answer of the Judge is : "I think the only reasonable construction that can be placed upon the Public School Act is that it is the duty of the Municipal Council not only to raise the money required for building schools, but also to pay it over to the Public School Board ; they shall pay the same to the Treasurer of the Board from time to time as required by the Board." In addition, a similar circumstance makes this rule clearly applicable to the local Utility. Please note this. The constituencies represented by the Public School Board are different and distinct from the constituencies under the jurisdiction of the municipal Council. This must lead to the inevitable conclusion that the moneys do not belong in any sense to the municipal Council, except as custodians. They are merely the holders of it for the Board until called on. The Judge in the Alliston case went on to say that, an individual public school supporter can be required to pay the tax rate himself to pay off the debentures used for public school purposes.

Therefore, the constituency is quite different. These moneys were held by the Town in trust for the School Board, and the logical result of the decision in our own Court is that the Board need not bring action to recover the money, but a mandamus may be granted against the municipal Council, requiring it to pay over the money. That will also reflect back on the previous argument. The local Utility represents a different constituency from the municipal Council. The municipal Council represents all the inhabitants and more particularly the electors of the municipality. The local Utility represents the consumers, and I am certain that this Clarkson *vs*. Alliston case will be used to establish the powers of the Commission if ever the matter comes to Court.

The next relation of the Commission is the relation to customers. There is a relation of rates. A Utility is a co-operative undertaking, and it is its duty to sell power at cost. There may be local circumstances to contend with, but I want to bring back to your mind again the analogy of the Trade Association. One of the most valuable functions of Trade Associations is the collecting and distributing of information as to absolute costs, and the rate base in each municipality should be established on a reasonable calculation of costs on general principles. If an attempt should be made to change the original structure, you can readily think of what would happen. A neighboring municipality would want to know why ; what is the difference in the cost, how is that going to affect our costs, for the other peculiar feature about local Utility Commissions is that you are not independent traders, members of an Association, but you are actual partners in an Organization purchasing power for each and every one of you. The relation of one local Commission to another is that of a partner, and they must carefully guard against anything which will injure the rest of the partnership. In their own self-interest they have got to avoid any reflection back on themselves. If they injure the partnership,

or the scheme, it is sure to come back and they will suffer in increased costs to themselves.

In relation to the arrears, it is an old story since 1926 ; but I want to remind you of the necessity of keeping arrears collected, because now you only have a lien for three months and that lien is not on the land. The lien is only on the estate or interest of the person to whom you are supplying the electricity. Take the case of a tenant. You have a contract with a tenant, and there are three months' arrears. What do you put on the tax roll? You can put arrears on the tax roll only against whatever interest the tenant may have in that land. That may be useless to you. There are two ways of meeting the situation. The reasonable way is to secure from the tenant in every instance an adequate deposit to cover your experience on arrears. Two or three months, I have heard said, is a fair average for deposit, and you are entitled to do so. That is the reasonable method of meeting it. There will be opposition from people coming into the town, but once the policy is established the people in the town will realize that it is for the benefit of everybody because it keeps down costs. There will be little difficulty except an occasional argument with an individual. There is another way in which, perhaps, it might be met, dependent on different circumstances, that is the case where tenants are changing often and it is hard to keep track of them. I still maintain that the deposit is the proper way of handling it, but it might be possible, in some cases, to take your contract from the landlord, or from the owner of the land. If the owner of the land signed—not as owner only—but signed as an actual consumer, then he has contracted with you to take a supply of electricity, and therefore you are entitled to put a lien on his land. Now, I suggest that only as an additional security in case of tenants changing often. The proper safeguard is a reasonable deposit.

Another question in relation to the collection of accounts is the matter of bankruptcy, and it also affects the contract that you have with the consumer who has gone bankrupt. When a man goes bankrupt, his property is put in the hands of a Trustee, who is a Trustee for the creditors, of which you are one, and there are no favors allowed ; but if anyone is holding security for the debt, then he is allowed to take the value of that security out of the account. You might take the case of a land mortgage, and that applies immediately in the case of a Utility account for electric current. The Statute gives you a lien on the land if the debtor owns the land, and it may be collected in the same manner as taxes. Therefore, to that extent, you have security, and to that extent you are entitled to prior payment from the Trustee, but only to the extent of the value of the land owned by the bankrupt.

In connection with the collection of accounts, there are two or three previous cases on that point. The case of A. Puchini & Company, Limited, in Canadian Bankruptcy Reports, before Mr. Justice Fisher. Other cases were cited, and notably the original one which he first decided, the case of Andrew Motherwell

of Canada and the Public Utility Commission of Dundas.

Next, what is the status of your consumer contract when the consumer becomes bankrupt? When a man becomes bankrupt, the law is well settled that a contract for the purchase of goods is not cancelled merely on that account. The terms of the contract must govern. To get a proper analogy, you must take the case of a man ordering goods for a period of months with periodical deliveries, which is often done. He wants a supply for his factory of raw material, and he makes his contract ahead of time for so many months, and deliveries come in periodically. When the purchaser becomes insolvent before the contract for sale has been completely performed, the seller, notwithstanding he may have agreed to allow credit for the goods, is not bound to deliver any more goods under the contract until the price of the goods not yet delivered is tendered to him in cash. Those on the way are due ; and if a debt is due him for goods already delivered, he is entitled to refuse to deliver any more until he is paid the debt for those already delivered, as well as cash on delivery for those still to be delivered. If there are arrears, then before you continue to supply current you are entitled to payment from the Trustee in bankruptcy for those arrears, and you are entitled to demand a deposit from the Trustee for future bills. If the bankruptcy Trustee does not, within a reasonable time, notify the vendor that he intends to adopt the contract, the vendor is entitled to consider it cancelled and to claim any damages which he is entitled to for breach of contract.

There are other matters affecting the relations of consumers where experiences from the Trades Association may be valuable. The question of selling power at cost has come up, namely, taking demand instead of rated capacity. It may seem a reasonable thing from the standpoint of immediate revenue not to base the bill on demand, but, when you have got to get down to the basis of cost, a man must pay on his demand, that is the cost of your capital investment. Demand must be the basis for calculation of cost if you are to get a reasonable and equitable principle applied.

There is one further consideration, and I see my time is practically gone. That is the question of public liability. You are handling a dangerous article, sometimes on the public highway, and because you are handling a dangerous article, the ordinary law presumes that you have to take extra care. There is the old case of Rylands *vs.* Fletcher, where a man built a dam and impounded a large quantity of water on his land ; the dam broke and he flooded his neighbor. He claimed he was not negligent ; that it was no fault of his the dam broke. The answer was that he had gathered a dangerous thing, and he was bound to see it stayed where he put it. So far as the Utility is concerned, there is another principle now to apply. You are a Statutory authority carrying out a Statutory duty, and as long as you keep within that authority and duty, and are not negligent, you are protected. Nevertheless, a greater standard

of care is necessarily exacted from you or they will be inclined to hold that you are negligent, because simply of the dangerous article. I will not attempt to go through the large number of cases affecting accidents, many of them from the other side, but simply leave that as a general principle that great care must be necessarily taken, yet if within your Statutory authority you are protected from all but negligence.

Discussion

Mr. A. B. Scott, Galt :

I would like to ask Mr. Hanna if, in the case of the assignment of a tenant, the claim we have is a preferred claim.

Mr. Hanna :

Well, that comes back to the question of what interest the tenant has in the property ; if it is a twenty-one year lease, he has a substantial interest that is taxable, and to that extent you would have a lien on that expired term of the lease ; but if he is a month to month tenant, he has practically no interest in the land, and therefore you have no lien, because your lien is only on the estate or interest of the consumer in the land.

Mr. Scott :

Not in any property, or stock or chattels?

Mr. Hanna :

There is another remedy you have in the collection of arrears. Under the Public Utilities Act, you are given the power to collect by distress ; but in dealing with goods and chattels, you have no prior claim unless you have actually seized, and it is the man who seizes first who gets the claim. Even then you may be stopped. If there is a Chattel Mortgage on the premises or the Bank has a claim, you would not succeed. In quite a recent case, where the person attempted to seize after the assignment, the first answer made was that the Bank had everything. The Bank had a Chattel Mortgage ; and therefore, at the time the bankrupt made his assignment, he had no goods, and there was nothing which could be seized.

Mr. H. F. Shearer, Welland :

Mr. Hanna did not touch on the question of taxes with regard to property held in trust by the Commissions. We have had a new Assessor appointed in Welland, and he advised me the other day that land held by the Commission was subject to taxes for school and municipal purposes. If that is the case, we have been slipping through paying only such taxes as the general tax on our land value. I wonder if that is right, or is there some other point that covers that assessment?

Mr. Hanna :

There is a provision made under the Assessment Act, which says that the Utility Commission pays taxes assessed on the land. You see, under the Assessment Act, the general exemptions under Section 4, Sub-section 7, provide that property belonging to or leased by any community or municipality or vested in or controlled by any Public Commission, wherever situated, and whether occupied for the purposes thereof or unoccupied—but not when occupied by a tenant

or lessee—shall be exempt. That is a general exemption on all property. Along about 1913, the question was raised, when competition with private Utilities was fairly keen, and it was settled on the same basis as the steam railways. The question is cropping up continuously. It has been flung in my face, when I go out, about Public Utilities not paying any taxes. There are two sides to it. In the first place, there are no profits, because they are a co-operative Organization selling at cost. Other co-operative Organizations are thriving in our community, and would not the same conditions in relation to taxation on income apply? The other side of the issue is the property held. You are quite safe in defending your position every time on the basis that you are in the same position as the railways. The C.P.R. is privately owned. Other railways are privately owned. Your Public Utility is a publicly owned Public Utility. The land is assessable, but not the improvements on the land—not the buildings and structures.

Mr. T. W. Duggan, Brampton :

Might I ask one question? I am the Hydro Commissioner of the Town of Brampton, with a population of 5,000. Would it be unwise or unfair to make a distinction between tenants and landlords in connection with deposits? We have about 1,400 consumers, and practically no trouble at any time excepting with tenants. Would it be wise to allow the old system to carry on and, in the case of new contracts insist on tenants making a deposit?

Mr. Hanna :

That really is a question of policy, but I personally think that there would be no difficulty in laying down the rule and in defending the rule before the public. You can tell them quite frankly that in relation to owners, their property is liable for their bills, and therefore the tenants must put up a deposit.

Mr. C. T. Barnes, Oshawa :

The question of business taxation has been brought up.

Mr. Hanna :

I did not attempt to cover the whole field of taxation, but there are two special things to remember. When you are occupying premises for business purposes, you are subject to a business tax on these premises. That is, a certain percentage on the value of the premises occupied. Then there is another side. That is, when you are engaged in something else than the supplying of electricity—such, for instance, as merchandising, or a store selling goods—you are conducting a business in competition with other merchants and that business is treated separately and is subject to ordinary taxation.

Mr. H. D. Rothwell, H.E.P.C. of Ont. :

I would like to ask Mr. Hanna a question in regard to the spending of surplus by the local Commissions and their handling of surplus moneys.

Mr. Hanna :

The history of dealing with surplus is rather a long one, and a tangled one. There are many pleas of special circumstances. From long experience it has been found necessary to control that surplus in the manner set out in the Statute. A municipal Council is always anxious, of course, to keep down the tax rate and make

good fellows of themselves in order to secure re-election at the next election. That is human nature, but they overlook the principle that the money of the local Utility does not belong to the Council. It is a business undertaking controlled by the local Utility for the benefit of the consumers, and is the money of the consumers. The Statute has said that the surplus from revenue can be applied in certain specified ways only—either new capital invested, or the retirement of debentures, or deposited for either of those purposes in the future, or for other things that will advance the interest of the Utility. Then the application of the surplus for those prescribed Statutory purposes is subject to the approval of the Central Commission because it has been found that the same plea of special individual circumstances has caused sometimes an unwise use of surplus.

I could give you a number of instances where attempts have been made to get at that surplus for other purposes altogether, and one of them, I believe, which is cropping up fairly frequently, is an attempt by Council to borrow money from the Utility. When it is borrowed, just try and get it back. I want to warn you, that borrowing is strictly contrary to the Statute. The only interest that the Council can possibly have in any moneys of the local Utility is the small surplus that may come from the actual supplying of electricity for street lighting and such public purposes as lighting the City Hall or Town Hall in the municipality. When you analyze all your costs and revenues, and find there happens to be a surplus on that particular branch of your work, then the Council may have some claim.

Mr. Harry Kerwin, Scarboro Twp.:

I would like to ask this question. A municipality sells debentures for the local Commission. Has the Commission any power to force them to sell those debentures when they desire them to be sold?

Mr. Hanna:

So far as I can find, I do not think there is any Statutory authority for the local Utility to compel the Council to raise the money by debentures, and pay it over on the instant demanded by the local Utility. But the Statute says they shall pay it over, so, if it is raised, there is no trouble about you getting it. You can go to Court and get a mandamus to require the Treasurer to pay it over ; but the other question, of the actual time of selling the debentures, the Statute has not covered that as carefully as it has been covered in the Public Schools Act, because the Public Schools have argued that they have got to carry on. This has been treated from the other angle that it is a co-operative business, and the residents of the municipality themselves, thus far, have fared fairly well, because the Councillors know there is a remedy at the end of the year if the consumers are not fairly treated.

Merchandizing Electric Refrigerators

By W. J. Daily, Sales Promotion Manager, General Electric Company, Cleveland Ohio.

(*Address to Association of Municipal Electrical Utilities at Bigwin Inn, Lake-of-Bays, Muskoka, July 4, 1929.*)

SEVERAL months ago, there was a gentleman in our office in Cleveland whom some of you know. He is a short, pompous, aristocratic sort of man. We knew him as Dr. Adolph, who is the head of a large chain of Public Utilities in Germany, with headquarters in Berlin. We were particularly interested in what Dr. Adolph had to say to us, because we knew he had made this trip primarily to talk about electric refrigeration, and he told us that he felt Germany was now ready to take its place in what he called the miracle industry. We had not thought of an electric refrigerator as any sort of miracle industry ; yet, when we recall, particularly for the last five or six years, the progress that has been made, we realize that Dr. Adolph was right. In 1923, for instance, 16,000 household machines were sold. In 1924, the figure jumped up to 30,000. In 1925, when the Associated Edison Companies submitted their report to the National Electric Light Association and approved electric refrigeration, the figure jumped to 100,000, almost treble the total in 1924. Then in 1926, it trebled again to 300,000 household units, in 1927 jumped to 400,000, and in 1928, somewhere in the vicinity of 465,000 household units were sold. In 1929, this year, the industry expects to sell something like 700,000 units.

I bring this out to indicate what has happened in the electric refrigeration industry and yet, gentlemen, we are not yet up to 7 per cent. of our market. There are only 47 per cent. of the people in America taking ice and only something like 18 per cent. take ice all the year round. So you can see there is a tremendous field ahead for electric refrigerators and ahead of the ice industry in America. There have been a great many problems in our merchandising set up which probably would not occur to anyone who is not directly connected with the merchandising of electric refrigeration, and we feel that the next ten years will see radical changes in distribution methods. We have only to look arond us to see the tremendous increase in house-to-house selling. Now-a-days, the housewife has almost to keep the door closed to keep out house-to-house operators, and we hear many discussions *pro* and *con*. Then there is the attitude of the retail salesman. He is taught to push the doorbell. Very often he pushes it and hopes to goodness nobody will answer it. There have been a great many problems in house-to-house selling and drilling men ; and I hope a little later on to go through a series of charts to give you an idea of the average electric refrigeration set up, to help the retail salesman to sell.

Then, there has been a tremendous increase, we notice, in instalment

buying, which has been of very great advantage to us. It has probably broadened the market to a very considerable degree. Then there is a tendency on the part of departmental stores to establish branches. There has been a tremendous increase in the mail order stores, and we see some better method of merchandising has got to be put into effect, and this seems to be augmented, perhaps, by two great actions which are going on now. One is the demand by manufacturers for more and more dealers, for the manufacturer feels, if he can only obtain enough dealers, his problem is solved. The other factor that is entering into this case is oratory. That is, the traveller has encroached on the middle man's profit, and it has upset the public mind to a great degree, and we are trying to find out something about that to see whether or not that opinion was right. As I see it, we have got to be increasingly aggressive in sales promotion in order to hold our place in this merchandising scheme ; and as I said a few moments ago, we are always active trying to find ways and means of getting the salesman across the threshold of the home, trying to find ways and means of getting the customer into the store, so that we may show the women exactly what we have. To-day, it is still true that the average lady and the average gentleman rather hesitate to come into a store where they feel there is some kind of trap awaiting them, probably to high pressure them into buying a product that they do not wish to buy at that time. We have spent a lot of time instructing our salesmen that the day of high pressure salesmanship has gone. It is not good business to force a product on a customer because, if everything does not work exactly 100 per cent., the customer is very apt to turn into a knocker and someone will defeat the object he has in mind.

I have brought up to-day a series of charts which we use in explaining to our dealers a sales promotion plan, so that they, in turn, can figure out the best ways and means of cashing in on them. We tell the dealer that he has to be active in sales promotion. We say he cannot help but realize his quota, and incidentally every distributor and every dealer has a quota of some kind that he has agreed upon. We feel there is a very valuable place in the merchandising of electric refrigerators for the Public Utility. We feel Public Utilities are authorities on merchandising for the public, and that people should look to them for advice on things electrical, and, as time goes on, they will become more and more a big factor in the merchandising of electrical things. They are going to be and very probably are interested in electric refrigerators because they have a day and night load, and can determine what kilowatt hours they may expect to sell, which they cannot do with any other appliances. They realize electric refrigeration does not depend on the whim of the user, but must be used day and night and this gives a constant load to figure on. Electric refrigeration is totally different from what it used to be. Several years ago, it was very difficult for a public utility to establish a comprehensive service. To-day, it is not necessary, for the average refrigerator will go on

and give intensive service, and several Companies have been successful in eliminating the service problems of the dealer, so that it is not necessary for him to service it at all, and that is truly an ideal situation for the Public Utility. As I said before, we feel that they are becoming more interested, and, as time goes on, will become increasingly more interested in electric refrigeration, for it is the most valuable load that can obtain, a day and night load. As time goes on, where we have dealers who are not very active, we tell each one that it is possible that they have not even scratched the market in their own section of the country. It is possible, because the country as a whole is not yet up to 7 per cent. saturation, so, in their section, they still have a great many prospects—and we attempt to differentiate between the prospect and suspect in their territory—that they can still sell, as the years go on, and realize more than their yearly quota. The quota is something to shoot at, and the quota we try to make is fair, something that can be reached ; and when they realize that quota and make 150 per cent. of that quota, as they some times do, it is the finest feeling in the world. But we say to them, "Are you getting the maximum amount of business from your territory? If not, isn't there something that you can do to get this business in there? There must be a scientific way of going after the business." There must be a cut and dried scheme of training men, of organizing sales crews, and all the other factors in obtaining business, and we feel that perhaps a comprehensive, efficient, clear-cut sales promotion programme can be of great help along these lines. It is our desire to help every distributor dealer obtain his sales. If he has problems, let us have them. If he has a district which he thinks is different, let us know exactly what he is up against. We will send a man out to attempt to help him as best we can. We will send a supervisor in there, or our own man will call and attempt to iron out any of the problems he has. First of all, we break down the market for them. There are over 19 million wired homes ; and out of those, less than seven out of every one hundred have electric refrigeration, and of the remaining ninety-three, 25 per cent. are immediate prospects.

It is impossible to dominate the electrical refrigerator business in your vicinity unless you will have an organized and efficient system of sales promotion, and we ask him to follow those thoughts, not that we think they are the best. First, there must be three Managers for distribution ; the Organizing Wholesale Manager, the Retail Sales Manager and the Promotion Sales Manager. The Wholesale Manager must know his territory ; and in order to efficiently and quickly see it, he should set up a map indicating the sort of dealers he has and where they are located. We always classify dealers into two groups; one is Public Utilities, and the other is all the rest of the dealers. I think you all know that the Public Utilities in the United States sold between thirty and forty per cent. of the electric refrigeration total in 1928, and this figure is going to grow larger, and every Public Utility, both in Canada and the United States, should get on

the band waggon, because it is going to be a tremendous business. It is going to be a business that sooner or later is going to reach into the billions, we feel.

The Retail Sales Manager has got to know his territory. He finds out the better sections of his town, and he indicates those districts as "(a)", "(b)", "(c)", etc. He is responsible for those districts and for the prospects that come out of them. He must know exactly the amout of business that can be obtained from those districts. Then comes the Sales Promotion Manager. He has got to know something about sales promotions that have been made, and he again has to have a map very similar to that used by the Retail Sales Manager, and here he places probably coloured pins indicating his installations in residences, apartment houses, schools, etc. In his map section, Salesman A. or Salesman C. has not obtained a great many installations. He knows he should throw his direct efforts in there ; he should get his telephone canvassers or something else in there. Perhaps District B. has run above it for no reason at all except that Salesman A. is not on the job. Then would come organization. It is necessary for the distributors and for the dealers to organize and, incidentally, it is becoming more and more necessary to establish the electric refrigerator as a separate department. A great many Public Utilities in the United States are doing that at the present time. But he very often looks for advice and help, and it is necessary for us to help him all we can along that line. Then would come store arrangement, and possibly the fourth one would be preparing the way for the salesman, and the fifth one, closing the sale. Now everything that is done is covered under those five denominations. In order that he may clearly file these, a filing case is suggested and everything is marked, for instance, such as literature, or an idea that may come out on the product would be filed. Every member of a Sales Organization, of course, has got to know the basic facts about the electric refrigerator. He has got to know something about the industry in which he is working, in order that he may successfully sell it, so there are several questions we ask him on the principles of electric refrigeration and so forth. It is not necessary at all for him to become an engineer, or to become too familiar with that phase of it. Employ the most capable man you can find. Then comes the problem of keeping the man after you get him. We say, "Sell him on simplified electric refrigeration." That happens to be our way of doing it. Hold frequent meetings. We see very great value in morning meetings before the salesmen start out, and we attempt to stress on the distributor or on the dealer the value of the statement, "Knowledge is power", that no weapon a salesman can have is of more value to him than knowledge about what he is doing and about the product and how to sell the product, and that it is very necessary for the distributors and the dealers to make their meetings into knowledge meetings rather than pep meetings. We feel that pep is more or less like a balloon, and that we can steam up a salesman in the morning with a lot

of pep and enthusiasm, and if he goes out that day and is not successful, the balloon is punctured, and next day he is lower than on the previous day, so we say, "Give them information, and give them everything you can to help them, and don't call in an insurance salesman and have him give a long talk on selling goods because he will forget all about it." Tell them something about electric refrigeration. The first thing we give a salesman, when he is employed, is a book. In this book, he is told something about the market, something about the refrigerator itself, so that he may have a story he can go home with and talk over with his wife, if he wishes ; but at least, he will have something additional to what has been told him by the Retail Sales Manager or the Wholesale Manager. The next thing, he is enrolled in a correspondence school sales course, which consists of sixty lessons, and we handle that in rather a unique way. The second lesson is not sent to him until the answers to the first lesson are received. So, right down through the list. We did not know whether this was going to work, but it has worked out fine so far. We have about twelve thousand students from all over the world, who are taking this salesman's correspondence course, and we receive answers in something like eight foreign languages. Then there is the Retail Salesman's manual. That differs again from the Sales Correspondence Course or from the selling. This retail selling manual gives him more information in a different way about his market, about the product, and about his own Organization set up. So far, he has three books that he has to study. Then after he has studied those books and got some enthusiasm into him. We tell him something about the product again, and then throw him into a contest with the other salesmen. There is nothing that will stimulate him more than the right kind of contest, if it is a properly conducted contest that is really inspirational.

A good looking store is an asset, and it is a valuable asset to a distributor particularly, but also dealers must have good looking stores in order to do a proper job. All merchandisers are, of course, more and more segregating electric refrigerators and placing them in a good looking section. We tell them it must be home-like; and when people think of refrigeration, they think of food, and when they think of food they think of cleanliness, and in consequence the store has to be clean. Then we come to the window display. Does he make his windows work in order to make his location pay? We tell him his windows are worth anywhere from 20 per cent to 25 per cent of his rent, and in consequence it is necessary for him to make his windows good silent salesmen, and if he is a dealer himself he has to be responsible for them; if not, someone else has to be responsible to tie in with current events or anything that is happening at that time. Now a great many distributors and dealers are interested in going into Fairs and Exhibitions. They are constantly exhibiting somewhere at the Ladies' Aid Society or at the Home Economics Exposition, or somewhere else. We tell him that practically 50 per cent of these are

not worth anything, that it is not worth while to waste his money exhibiting in all kinds of places, and that unless a Fair or Exposition is a market place where one can actually go and do some selling, it is a waste of money because, as we see it, there is no publicity value in a Fair or Exhibition. We prepare a book for the dealer to tell him how to make displays at Fairs and Exhibitions and in a little paragraph at the end, we call it, "After the Ball is Over", we tell him the story. He has his prospects' names —or he should have—and here is what he can do. He should have a filing system. He should have a good set of cards. He lists these cards under their headings, "Good", "Fair", or "Bad" prospects, what they are using now, ice or electric refrigeration, what size box they are using, perhaps— and all sorts of information like that for use when he should call upon his prospect. Then the next point is when he should send them the next piece of direct mail, and so forth. It is usually done by a set of cards in triplicate. The salesman takes one, the office keeps one, and there is one kept on file; so there is no chance of that prospect's name being lost entirely.

Now it is necessary for the distributor to advertise in a great many ways. One way is this "Year-round" campaign. Direct mail is sent out regularly every month until the prospect is either sold or worn out. But direct mail, we believe, should be just as consistent as National Magazine Advertising or as Newspaper Advertising, or as Billboard Advertising.

Now we come to the Architect. He is a big factor, particularly in the larger cities, and we have to tell him the story, so we prepare a special book for him, which tells him exactly what he wants to know; but before doing this, we went to the American Institute of Architects to find out exactly what the American Architect wanted to know and what they felt it was necessary for him to know. The Telephone canvass is used, to obtain prospects' names. Eight girls in New York City, every day and all day long, do nothing but operate this canvass. They have a set line of conversation. Their words are all exactly given to them, and they read them off a sheet. They know exactly what they are going to say. They have exact answers, as far as possible, to any question a person on the other end of the telephone may ask. Now the thought might occur to you that people would resent this; but you would be surprised. We have very, very few cases of resentment. I don't recall any offhand, but I know there have been one or two in New York City, and these eight girls have drummed up a vast amount of prospects by this method. There is a comprehensive system of follow-up. They are placed in the prospect file. The salesman should, perhaps, call immediately. Then a piece of direct mail is sent out, and the telephone canvass perhaps is repeated in a week or so.

Then comes the apartment house salesman. He, of course, is in a class by himself. He is separate from the house to house salesman, and separate from the commercial

salesman. He has a different kind of story to tell.

The commercial salesman again is separate. He has got to have his way, his plan of action, his way of going after it. He has got his water cooler market, which again is different. He has got to sell two kinds of water coolers—the pressure cooler for ordinary city water, and the bottle coolers; so there is a different line of action for him.

We found there were no facts and figures on the electrical refrigeration industry in the United States, and every fact we have been able to get we have had to go out and get ourselves. We couldn't obtain any from the electrical publications, from the National Electric Light Association or from anybody else. We had to analyze those lists and find out exactly where our market lay in selling water coolers or electric refrigeration.

Now there are various kinds of motion picture films used offering a varied number of things. In addressing Women's Clubs, they will have a particular set-up for them. For training salesmen and in explaining the operation of the unit there will be a very comprehensive set. We have had one thing that we think is a very valuable form or piece of ammunition, and it is called the "Salesman's Presentation Book". It is our thought—and the thought of a great many other people—that no salesman can logically and convincingly present all of the points of any one product at any time. He simply cannot remember all the facts. His mind is turned by a question, perhaps, or by a comment a prospect might make, and in consequence we give him this story in a picture book that he can actually lay before a prospect and go through from start to finish. In order to sell the salesman on this thought, we wrote this little article. "Memorize or Extemporize; Which?" "A certain French Statesman was praised because his sentences 'flowed so easily and were obviously so spontaneous'. And he answered that the spontaneous quality of his speeches cost him many nights of toil.

Champ Clark, one time speaker of the National House of Representatives, upon being congratulated for what was called a masterpiece of extemporaneous eloquence, replied: 'That was a written speech. I knew it so well I could have delivered it backwards. No man ever delivered a speech worth remembering that he did not prepare in advance".

Mr. Dodge, Professor of English in the University of Illinois, stated he could prove that Lincoln's Gettysburg address was *not* hastily written on the back of an envelope by Lincoln as he travelled to the battlefield, but was the result of ten days' hard work.

There is no need for DOCUMENTARY evidence. The Gettysburg speech tells its own story. Every sentence makes clear the careful writing and re-writing. It was hard work and careful work. Lincoln had too much respect for the occasion to rely on inspiration.

It was Daniel Webster, one of the greatest of modern Orators, who said that *it took a long time to prepare an extemporaneous speech.*

Any man accustomed to public speaking can hold the floor for two hours without previous labour. But

an orator who could put over an idea in twenty minutes must work for many hours to eradicate the puzzling unessentials and prepare himself to say the necessary things clearly and simply.

Does not the same thing hold true of salesmen! Read what Mr. W.G.G. Benway, Branch Manager, Union Central Life Insurance Co., says in part on this subject in a recent article in Printers' Ink:

"Salesmen who think and plan before they act are invariably more valuable than those who have the blind staggers and rely only on their mentalities when they are face to face with prospects.

Mediocre salesmen adopt a hit-or-miss program dependent on the circumstances of the moment. The current alibi is that 'You can't treat all prospects alike'! There's enough truth in this statement to seem to justify it, but as a policy it is disastrous to salesmen. Human reactions are much the same and must be governed by certain fundamentals. The actor who would attempt to improvise on the stage would be asinine indeed. His failure would be quick and certain.

Repetition does not deaden the work of the actor, nor is he less an artist because he repeats the words of another. To be sure, a clever actor needs a skilful playwright and director, but he is no less an actor because of this fact.

Successful salesmen, as well as men successful in every line, owe their success to personality plus a systematic routine strictly adhered to. They are merely actors who have learned their lines well, realize the value of props, and who do not lose buoyancy in the daily performance.

One great failing that many salesmen have in common is their unwillingness to follow a charted course. They yield to the blandishment of an ego they do not realize they possess and instead of profiting by the experience of others, follow the costly practice of finding out for themselves facts that have been long known to others, of which they could have become possessed merely by a willingness to listen and learn.

A sales talk is a series of logically arranged, inter-related, major ideas, so emphasized and illustrated as to arouse enthusiasm for and have a tendency to engender the action toward the object intended. A sales talk is not a haphazard conversation about a proposition—not a battle of wits on the spur of the moment—but a carefully laid plan of arguments.

The arguments that are good today are equally effective to-morrow. The big thing is to present the major ideas in logical order with the most telling effect."

Is it not perfectly clear to those who "want" to see that presenting "the major ideas in logical order with the most telling effect" can best be accomplished through memorizing a sales talk word for word, and then practicing until the sales talk becomes

a part of oneself? Without memorizing, the chances are nine out of ten that the sales talk will drift from one point to another in such a way as to leave only a hazy and muddled impression in the mind of the prospect.

Experience teaches (but most of us "close up like a clam" to its teaching), that the efficiency of a salesman who has learned a standardized sales talk will show as much as fifty to one hundred per cent. over the old hit-and miss method.

The first few days with a standardized sales talk, memorized by the salesman, are pretty sure to be unsuccessful and miserable ones. The salesman does not find himself getting any where, seemingly, by using the parrot-like repetition. He forgets passages, stumbles, stammers. He feels the standardized talk is a senseless, useless incumbrance, and he wants to cast it aside. But after the initial few days, when the whole plan tends to disgust the "average" salesman, there comes a day when the salesman is very "flip" with the talk and he begins to make the mistake of rattling it off too fast.

About this time he begins to get results with it and his courage picks up. The next stage is that of real mastery, when the salesman learns the trick of apparent spontaneous pause, a deliberate but apparently groping for a thought. As he, more or less automatically, presents arguments, he is able to study the prospect, his re-action much more naturally and accurately than when groping for words to express his thoughts as he goes along. He detects things he ordinarily would not detect, and can depart from the standardized sales talk, adapting it to the individual as circumstances render best. His efficiency with the standardized presentation will be far greater than under the old hit-and-miss, trial-and-error, hodgepodge scrambled egg presentation.

One of the great possibilities of the standardized sales talk is that it will make a big producer of a "green" man far more quickly than any other known policy. It will also increase the efficiency of the "ripe" salesman, provided that he is not so over-ripe that the germs and bacteria of "know-it-allness" and mental laziness haven't him ready for the garbage can of "has-beens".

We always conclude a presentation of sales promotion to a dealer by telling him, if he has a policy that will actually carry out this programme, will use every possible piece of ammunition that he has, he will have a better organized and more efficient sales force. He will have a store that stands out in his community and attracts more business; he will have a knowledge of his market that enables him to find every possible prospect; he will have prepared the way for his salesmen into the homes of his community and will have equipped his salesmen with material to help him close more sales. Now everybody here is selling, whether he is an engineer, or whether she is a wife, or just merely an onlooker. We have to sell ourselves to our boss, to our wife, to our husband, to ourselves. Recently I ran across a few points that may be helpful. I know they have been very helpful to us. I listened to two Professors from the New York University, who had spent seven and a

half years, not as College Professors, but as salesmen out in the field, in purchasing offices, as stenographers, in anything at all. They have been given thousands of sales presentations in those seven and a half years, and have listened to twenty thousand presentations of sales arguments, and they arrived at a set of six facts which will help any salesmen at all, or anybody who has anything to sell, provided he has the fundamentals and provided he knows his product and his market. The first thing is, when a salesman, or husband or wife or businessman, is talking, don't talk too much—don't say so much that the persons you are talking to or with cannot answer, because most of us like to say something. The second one is never interrupt a prospect, particularly the boss or the wife. Allow them to say anything they want to say, because nothing is more irritating than interruption. The third one is watch your manner. The average salesman becomes antagonistic, without knowing it, when a prospect makes objection. Some times he does it in a sarcastic manner. The salesman should be on his guard and never answer in a like manner. The fourth one is enquire as to the line of attack. That is very closely allied to the third point. In other words, when a prospect makes an objection don't attack him, tell him his opinion isn't quite clear; ask him why he thinks the product you are selling isn't right. Let him state his objections, in other words, and then go on and use the fifth point, which is to re-state the objection. When the prospect makes an objection, re-state it to show him that you clearly understand the objection that he has. There is a psychological point there which is often very valuable. The prospect feels you don't understand what he means by his objection, or else you have paid very little attention to it. The sixth one is pick out the key issue. If there are several objections to several points—pick out the one you think is the most important and usually you can arrive at that conclusion. If it is the selling of electric refrigerators, perhaps convenience appeals more than any other, but you have perhaps reached a home where there is a small child dependent on milk and where the health factor depends more than anything else.

The Prevention of Accidents

By Wills Maclachlan, Employees Relations Dept., H.E.P.C. of Ont.

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities, at Bigwin Inn, Lake-of-Bays, Muskoka, July 3, 1929.)

As you know, we have been carrying on an educational campaign in connection with the prevention of accidents amongst employees of Public Utilities in Ontario now for about fifteen years. We have got somewhere at least in connection with it. In the group of Utilities under Class 22, under the Workmen's Compensation Act, in which most of the Utilities here are included, 85 per cent of that group went through last year without a lost time accident. 65 per cent of the group went through five years without a lost time accident. That is what can be done by organized effort. But what I want to say this afternoon, I want to say principally to the Managers and to the Commissioners present. You have been given the responsibility of operating a Utility in the Province. Back of that responsibility is to operate it in such a manner that your employees will not get hurt, and in such a manner that the public will not be injured. I have heard it said so many times that accident prevention is simply a frill in any industrial activity. If you had been in my office one day the early part of last week and had helped a foreign woman make out her application for pension after her husband had been killed—a woman with no friends, no relatives in this country but a little baby five months old—you would know what accident prevention and what fatalities mean. Unfortunately, that is part of my job. Or if you had been with me last Friday afternoon receiving long distance calls and calls over the private line, knowing that men were working on a youngster of six years old that had brought a guy wire in contact with 2200 volts and was horribly burned, knowing that those boys were fighting for that life, (which unfortunately, they were unable to bring back), you would realize what accident prevention might mean to the public. That is part of your responsibility as much as it is your responsibility to carry out the other activities of your Utility. How can it be accomplished? I just want to speak for a very short time on it.

The most serious types of accident that we get in this Province are those of linemen working on or near live primary lines in the smaller municipalities. Except on very few occasions the only time a lineman need go near a live primary line is when he is cutting in a new transformer, and, in the average municipality you are not putting in more than possibly ten transformers a year. That means ten transformers that you have to cut in on the primary lines. Make it twenty. To do that job needs a

shut down for about half an hour. Twenty minutes will do the work. But do you shut down for half an hour? By putting in sectionalizing switches, you can limit the extent of the shut down. Now, is the necessity of maintaining twenty-four hour service in residential districts so important that you have to risk the lives of your linemen to do it? That is a problem for you yourselves to consider. A great number of municipalities have considered that it isn't worth while, or, as I have put it at other meetings, Mary Jones' washing isn't as important as Bill Smith's life. By putting in your sectionalizing switches, by organizing your shut-downs—you have only an average of about twenty a year at the maximum—you can make it possible for your men to do that work absolutely safely, and do it better when they are working on dead stuff than when they are working on live. What I am leading up to is the very definite principle in the smaller municipalities—and I know some reasonably large municipalities that are carrying it out—of the Commission to consider the policy of no live work. Large Organizations, such as the International Nickel, can carry through all their activities in the Sudbury plant and maintain that policy of no live work, and in the fifteen years I have been dealing with that Utility, I have yet to have one lost time accident.

There is no use in talking to your men. There is no use my talking to your foremen or your managers to put that policy into effect, because I know, and you know, that as soon as you have a shut-down about which you didn't give the public warning ahead of time, some one is going to kick to the Commission about the rotten service he is getting, and that Commissioner, unless he has an answer ready, would jump on the foreman for shutting off the juice. If that had been discussed at the Commission meeting earlier, then you would have an opportunity of laying down a definite policy.

In connection with accident prevention as regards the public, I hope that some time this Association, the Hydro-Electric Power Commission, or some body in the Province, through the Educational Department, if you will, will carry out an educational campaign in the schools of the Province with a view of trying to cut down, if not entirely stopping, youngsters playing around wires and climbing poles. They even climb towers. One kid last year climbed right up into a 26,000 volt circuit after a bird's nest. The poor youngster was horribly burned; and in the Toronto General Hospital to-day, we are trying to save as much as is left of a boy nine years old after he came in contact with 26,000 volts. By instituting an educational campaign in the schools, we may be able to get somewhere in this thing. I have just tried to touch the high spots, but the point I have tried to leave is this, that this is a job for and with the authority of the Commission and the Managers and is not a job wholly for the men.

Pension and Insurance Plan

By N. W. Streat, Confederation Life Association, Toronto

(Address to Ontario Municipal Electrical Association and Association of Municipal Electrical Utilities, at Bigwin Inn, Lake-of-Bays, Muskoka, July 3, 1929.)

AT the request of Mr. V.S.Mc Intyre, Chairman of the Pension Committee, it gives me great pleasure to attend your Convention and present to you a report on the present standing of the Pension and Insurance Plan inaugurated for the benefit of the employees of the various municipal public utilities.

I should explain that I am not a member of that Committee but am employed by the Insurance Companies who were entrusted with the underwriting of it, and I was requested by Mr. McIntyre, the Chairman of the Committee, to make this report to you simply because I am dealing with it all the time and it is therefore only reasonable to suppose that I know pretty well what is going on.

Those of you who attended the meeting of the Association held in Toronto in January and were fortunate enough to hear the address of the Hon. I. B. Lucas, which very clearly outlined the provisions of the Pension Plan, will be familiar with its general structure. Unless you wish me to do so, I do not intend to cover the same ground but will report only on the progress that has been made since January. I would, however, like to quote from Mr. Lucas' address the last two paragraphs, because it seems to me that, whenever we meet to consider this Pension Plan, we should always bear in mind the principal reason for its creation, and I cannot find better words to express it than those adopted by Mr. Lucas. This is what he said:—

> "Mr. Chairman and Gentlemen, various forms of group benefit insurance are sweeping over this Continent. In my judgment, public opinion will not justify big industry or business 'scrapping' old time employees and leaving them to the support of relatives or public charity, and much less will public opinion justify public utility commissions scrapping their worn out employees without making some provision for them. As a matter of fact, public commissions realizing the trend of public opinion do not usually scrap their old time employees but try to take care of them by keeping them on jobs where they are no longer efficient. It looks like better business to do it under a sound Pension Scheme."

Those are the words delivered by the Hon. I. B. Lucas at the last Convention, printed, I think, in your last BULLETIN.

Since January, a number of meetings have been held of the Pension Committee which have been attended also by Prof. Mackenzie, Mr. Clarkson and Mr. Lucas and the remaining

difficulties have all been smoothed away so that now both the policy contract between the Insurance Companies and the Hydro Electric Power Commission and the Agreement between the Hydro Electric Power Commission and the Municipal Authorities have been put into final form and have received the approval of the Committee and of the Hydro Electric Power Commission. Nothing more remains to legally instal the Plan on a permanent basis for those municipalities who have adopted it than the passing of the necessary Order-in-Council and this, we are given to understand, will be done about the beginning of September.

The task of the Committee during these last meetings in getting the Plan into a officially approved shape was not an easy one as the problems were difficult of solution. In order to give you some idea of the nature of these problems a recital of the changes made since your meeting in January will be of interest.

First—It was found necessary to introduce a maximum for the life insurance as it was not desirable to have a few lives insured for very much larger amounts than the average. After much discussion, it was finally agreed that the maximum amount of life insurance that may be purchased by the Municipal Authority on any one life in any policy year is limited to one-half of one per cent of the total insurance in force in that policy year on all Municipal Authorities covered by this plan. That won't affect very many of the Municipal Commissions. It is a provision just to safeguard the plan in exceptional cases.

Second—For the same reasons, a maximum pension was found desirable and this was finally fixed on the basis that—When the total amount of Service Annuities purchased in respect of a Contributing Employee by the Municipal Authority will provide a pension at age 65 equal to Four Hundred Dollars ($400) per month the Municipal Authority will purchase no further pensions in respect to such Employee. Briefly, that means that the Municpal Authority will buy a pension up to the limit of $400.00 a month, but that $400.00 does not include the amount of pension that would be bought by the employee's own contribution. His own contribution might bring it up to five or six hundred dollars, according to the amount of his contribution.

Third—In order to offset the effect of the new maximum provision and also to provide a channel through which employees could make greater provision for their own retirement, it was felt that no limit should be placed upon employees' own contributions; and the following provision was, therefore, incorporated — A Contributing Employee may contribute toward the purchase of his Income Annuity a percentage of his salary or wages greater than 2½ per cent. and subject to the approval of the Commission no limit is placed on the amount of such extra contributions.

The reason behind that, is that the actual cost of the pension to the employee is a bargain, without any doubt. He can't go out and duplicate it anywhere else, and it was felt, therefore, that it was good business

to give him the opportunity of increasing his own contributions to so increase his pension.

Fourth—With a view to insuring that the operation of the Plan should always produce the best results and not inflict any hardship and to enable the various municipal commissions to retain complete management of their own affairs it was found desirable to remove the arbitrary retirement clause which provided that while 65 was the normal age, 55 the earliest, 70 was to be the compulsory age at which retirement must take place. To accomplish this object, the 70 year limit was entirely removed and there is now no age limit at which a man must retire, providing the Commission is desirous of retaining his service.

Another reason for that, gentlemen, is the fact that, at the inception of the plan in the early days, there will be a great many men coming in in the late 40's and early 50's, and even later, who wouldn't have time to accumulate a reasonable pension but, by pushing back their retirement age, some leeway is given, and there is a decent chance to get a reasonable pension when they do require it at a later age.

Fifth—To make the life insurance provision harmonize with this new retirement clause, it was arranged that, if the employee continued in the service of the municipal authority after age 65, the insurance on his life would be reduced to 70 per cent. just as if he had retired at age 65.

Two other very important points were settled by your Committee. The first was with relation to the Service Annuity "A", which is the Pension purchased by the Municipality for past service. The original clause was so drafted that service was calculated from 1910 and if the cost of the full service of all employees exceeded the limit set by the Commission, i. e., $1\frac{1}{4}$ per cent. of payroll over 30 years, then the starting date was advanced from 1910 forward as far as necessary. This had the unfortunate effect of causing the long service employee to bear the whole burden and was forcibly brought to our attention when we applied the formula to the first municipalities whose figures we received. The suggestion finally adopted was that instead of bringing the date forward from 1910 we shave an equal amount of service from all employees by taking off service from 1929 backwards. This is obviously much more equitable and much more satisfactory to all concerned.

One of the very interesting provisions of the Plan is that after twenty years' service all rights in the Pension vest absolutely in the employee and as a result of the limiting of service to be credited under the maximum cost provision, some employees might work twenty years without getting twenty years credited towards possession of their interest in the Pension. As this was not the intention an amendment was made to the contract which provides that all continuous service with the municipal authority after the first day of January, 1910, shall count toward the twenty year period required to give the employee a right, title and interest in the Service Annuity.

After the alterations and amendments which have been outlined had been finally decided upon under the

guidance of the best and most conservative actuarial advice, the plan was all ready to go into operation but it was necessary to secure the assent of a number of larger municipalities so that they could go in simultaneously to give sufficient volume to be sure of stability and an arrangement was made with the Insurance Companies whereby this could be done when a certain number of the larger centres had agreed to adopt the plan. There was, however, one difficulty in the way of its immediate adoption, which was that Mr. Lucas informed us that it would be September before the necessary Order-in-Council could be secured. This was felt by the Committee to be a serious matter, as with the plan all ready it was more than possible that while we were waiting for the Order-in-Council, deaths might take place and there would be no provision for life insurance benefits.

To overcome this difficulty, a provisional arrangement was made with the Insurance Companies whereby they would agree to take on the risk for the full benefits during the interim between the approval of the plan by the Committee and the Ontario Hydro Electric Power Commission and the passing of the order-in-council. The basis of the provisional agreement rests upon an exchange of letters.

All that the letters say, gentlemen, is that the Public Utilities Commission agree to pay the deposits, and the Insurance Companies write a letter agreeing to accept the risk; a perfectly simple little contract of a temporary nature, until the passing of the Order-in Council. Now it is interesting to note that, operating on this provisional agreement the present position is that the following municipal utilities are now enjoying the full benefits of the Pension and Insurance Plan, and in fact in one case a death claim has already been submitted:—

London, Windsor, Hamilton, St. Thomas, Brantford, Kitchener, Chatham, St. Catharines, Stratford and Woodstock.

For all these places, the plan is in full operation, the employees are covered, contributions are being made, and both insurance and pension benefits are secured.

The total number of employees covered is 616 for 9 municipalities. The total insurance in force is in excess of $1,150,000.

The total pensions for past service purchased by the Municipalities, $65,000 per annum. The annual outlay by the 9 municipalities is $58,000 per annum. The annual outlay by the employees is $25,000 per annum. These figures will be largely increased by additions for Ottawa and Walkeville, both of which places are now covered.

In addition to these 9 municipalities where the plan is in full effect, we have received figures from Toronto, Chesley, Tillsonburg, Perth, Milverton, Collingwood, Leamington, Hanover, Owen Sound, St. Mary's, Stratford, Prescott, Kingsville, Sandwich, Elora, Durham, Niagara Falls, Uxbridge, and Lindsay, and I believe one or two others came in after this list was compiled.

Might I say here that it would help very considerably if the various Commissions would forward the necetsary information for the calculations to be

made without waiting for me to come round to visit you. I will get round as quickly as possible, but it is a big Province.

The necessary agreements are now ready for signature. Each employee will receive a document something like a small Savings Bank Book, which will outline his benefits and in which he will have marked up from time to time the amount of life insurance he is entitled to for the next year, the amount of pension purchased for him by the Municipality, and the amount of his own contributions. We have also prepared some folders for the information of the employees.

It is extremely important, gentlemen, that the employees should thoroughly understand and appreciate the benefits of the plan which are amazingly generous. On this point, we have had by now some considerable experience and where it is impossible for me to attend to address a meeting of employees I shall be glad to supply the Manager with an outline which has been found effective in explaining the scheme to the employees.

In conclusion, I wish to pay a tribute to your Pension Committee. As I have not personally had anything at all to do with the drafting of the plan, there can be no suspicion that I am being self-congratulatory. A Pension Plan, gentlemen, is the most difficult piece of machinery to devise and in a case like the present is beset by a variety of difficulties and obstacles. Now, that we have had an opportunity of measuring the finished work against the circumstances in the various public utilities we can say without hesitation that it fits beautifully and will work perfectly. We have had some considerable experience on Pension Plans and in our considered judgment this is the most scientific and flexible piece of work that has yet been brought to our notice. Your Committee, of course, had the advice and assistance of experts—Professor Mackenzie from the actuarial side, Mr. Clarkson as financial advisor, and the Hon. I. B. Lucas from the legal point of view, but nevertheless is was the Committee that out of their experience criticized and discussed the Plan until all difficulties were resolved and its final form became possible. I feel confident that they will take satisfaction in the monument their labours have created which I am certain will be a tremendous and potent factor for bringing additional peace of mind and sense of security to a large body of public utility employees, that will tend to make for social stability and that all you gentlemen, as the active executive heads of various publicly owned utilities, will find, in your experience, to be of valuable assistance to you as an aid to effective management.

Discussion

Mr. Claude Ekins, Thorold: We have a man who has been thirty years in our service. He is under sixty to-day, and if anything happens him before he is sixty-five, what would his widow and family get?

Mr. Streat: A year's salary plus 2½ per cent of salary for each year of service from 1910.

Mr. Ekins: Then, if a man would carry on till the age of seventy—

Mr. Streat: He never gets any more; but at 65, it gets down to 70 per cent of the maximum.

Chairman: I think we could take an extra five minutes and let Mr. Streat give us a sort of sketch outlining the whole thing for the benefit of those who are not familiar with it.

Mr. Streat gave a detailed explanation of the Pension Plan of which the following is a condensed summary— "I am going to preface what I have to say by making a suggestion that the Pension Committee which has done such excellent work should continue to function for possibly a year or more so that there may be a central negotiating body familiar with all the details. Its usefulness will be unquestioned in helping to smooth out little difficulties which may arise from time to time before the Plan is working quite smoothly all over the province.

It might be well to remind you that there is not here this afternoon a representative from any Municipal Commission, with the possible exception of the City of Toronto, that could buy, by themselves and for themselves, the benefits of this plan. The whole structure rests upon the assumption that it is a co-operative affair, that the various Municipal Utilities throughout the Province will join hands and do together for their employees what it would be totally and absolutely impossible for them to do by themselves."

Mr. Streat then distributed some diagrams to the delegates and asked them to follow his explanation by reference to the diagram and proceeded as follows:—" Now essentially and basically, this scheme is a pension scheme. That is, the backbone of the whole thing, a scheme to provide a reasonable pension for the Hydro employee who reaches the retiring age. If you will look at this graph, you will see, in the centre a pension block. This, as you will see, is divided into three parts. First, a pension for past service referred to as Service Annuity "A".

That is the pension which is bought for an employee by the Municipality for his past services, dating back from 1910 up to the time that the plan goes into operation for that particular Municipality. Now what is the reason for that? The reason is that it is impossible to create a pension fund which will give reasonable results, in pension, to men coming into the plan at age forty-five, or upwards, unless you take into account the time that they have already served you and compensate them for that by pension. Now let us take an illustration. For Past Service the amount of pension is to be 1 per cent. of salary multiplied by the years of service. Now, gentlemen, perhaps the simplest illustration will be to work on $1,000. Let us take a nominal salary of $1,000 and let us assume that the man has ten years' service. He will get 1 per cent. of that salary, multiplied by ten years. That is $100.00 per annum in that top column for past service. Now that is the basis of the pension. That is the first part of it. 1 per cent. of

the annual salary, multiplied by years of service. Now, this is only an outline. There are some rocks there. It may not be possible to credit him with all his services, but I am not going to take up your time explaining little difficulties of that kind now. They will crop up when we deal with your individual commission. Now, gentlemen, that top pension is paid for entirely by the municipal authority. There is a limit set to the amount of money they may expend for that pension. That limit is a sum of money which may be retired over a period of thirty years by annual payments not exceeding 1¼ per cent. of the payroll. That is shown here on the left of the graph. Now, then, we have this man with a pension for past services, and the plan comes into effect. We begin to build up for him a pension from today onwards. Once again, we take 1 per cent. of his salary and every year we buy for him a pension, payable normally at age sixty-five, equal to 1 per cent. of his salary; so that, if you take this man once again with a salary of $1,000, we would buy for him next year a pension of $10.00, or, assuming that he has $100.00 a year for past services, at the end of another year his pension at sixty-five would be $110.00. At the end of another year's service, we buy another 1 per cent. That would make his pension $120.00, and so it would go on: 1 per cent. of each year's salary added to the number of pensions already bought to make the total. Now that pension also is bought by the municipal authority. I will deal with the question of the cost of that in a moment, because I want to link it with the life insurance. Let us finish with the pension. We have got the pension for past services. We are buying the man a pension for future services. Now we go to the employee and we say, "Here is the basis of a very reasonable pension" but in order to make it really adequate it is necessary that you yourself do something,—contribute to the scheme. This is a joint effort by the employer and the employee, and so we take from the employee 2½ per cent. of his salary every year, with which he buys a pension. Now if you were to take a man on a one thousand dollar a year salary as an illustration and, say, age forty, he would have twenty-five years. That is, if his salary did not increase, he would buy for himself $126.00 a year pension in that way, so that you would have a man coming in at forty, finishing at sixty-five, drawing never more than $1,000.00 a year, and retiring with a pension of $476.00. But you see it comes about 50 per cent. of the salary for that length of service and that age. It may buy more pension, for other ages, but that just gives you an idea of the size.

Now, while we are on the question of the employee's contribution, I want to say that that money is his money. It is always his money, and it can't get away from him. It is a live, die or quit proposition for the employee. If he lives, he gets it as a pension; if he dies, he gets all he has paid in, addition to his life insurance paid, to his beneficiary; if he leaves your service, he gets his money back. It is a most generoue plan from the point of view of the employee. On the left here, you

will see a provision for life insurance. The normal life insurance is one year's salary. There is a minimum of $800.00. No one will ever receive less than $800.00. But you have very few employees working for as little as $800.00. Normally, it will be one year's salary plus 2½ per cent. of the salary for every year of service. Take a man with $1,000 a year and ten years' service. He would draw one year's salary plus ten times 2½ per cent. (25 per cent.), $1,250.00 life insurance. That would go on increasing until the man has credit for twenty years' service, when he would have 1½ years' salary as life insurance. That, gentlemen, is the maximum. Have I made that clear? Now, after retirement, or at age sixty-five, in any case the life insurance is cut down to 70 per cent. of the amount that the man would have received in his year of service. That is not a hardship, gentlemen. It is a perfectly reasonable provision. The average man doesn't require so much life insurance when his family is grown up as he does during the middle years of life, and the cost of life insurance for the older ages is heavy, and it would have the effect of cutting down the benefits to all concerned if we didn't reduce this life insurance at the older ages. After retirement, he is always covered, however old he may be. The cost of the life insurance and the pension for Future Service is 5 per cent. of the payroll, so that the total cost to the Commission is 5 per cent of payroll and for a period of thirty years an additional 1¼ per cent. i. e., 6¼ per cent. for 30 years at the most, after that five per cent. of payroll."

Mr. Streat then explained the provisions in the Plan for the refund of money to the Municipal Authority and to the employee in case of leaving the service and explained further what happened in case of transfer. He also pointed out that after twenty years' service the employee acquires full possession of all contributions made to his pension by the municipal authority as well as his own.

Association of Municipal Electrical Utilities

Minutes of Convention

The twenty-fifth convention of the Association of Municipal Electrical Utilities was opened at Bigwin Inn, Lake-of-Bays, Muskoka, at 1.45 p.m. on Wednesday, July 3, 1929, with the President, Mr. A. W. J. Stewart, as Chairman.

It was moved by Mr. R. L. Dobbin and seconded by Mr. Harry Kerwin, THAT Messrs. P. T. Siebert, B. Pyburn, A. H. MacDonald and W. B. Munro be accepted as Associates, and Lyman Tube and Supply Company, Limited, C. L. Turnbull Company, Limited, and Thor-Canadian Company, Limited become commercial members.—*Carried.*

Mr. J. W. Peart, Chairman, Rates Committee, presented a report from that committee and moved its adoption. The motion being seconded by Mr. A. B. Scott was *Carried.*

Mr. N. W. Streat, Confederation Life Association, Toronto, presented a report on behalf of the Pension and Insurance Committee, after which he answered a number of questions asked by the delegates.

Mr. Wills Maclachlan, Employees Relations Dept., H. E. P. C. of Ontario, gave a short address on "Accident Prevention" after which the first session was adjourned.

The second session was called to order at 10.00 a.m. on Thursday, July 4.

Mr. W. J. Daily, Sales Promotion Manager, Electric Refrigerator Dept., General Electric Company, Cleveland, Ohio, gave an address on "Merchandising Electric Refrigerators".

Mr. H. M. Towne, Engineer, Lightning Arrester Dept., General Electric Company, Pittsfield, Mass., read a paper on "The Lightning Problem in Power Transmission and Distribution", after which the session adjourned.

At 12.30 p.m. the delegates met for the Convention Luncheon, when Mr. W. J. Daily gave an address on "National Food Preservation Programme".

At 7.30 p.m. there was the Convention Dinner when Mr. C. A. Maguire, President, Ontario Municipal Electrical Association was toastmaster. The guest of the evening was Col. W. W. Pope, Secretary, Hydro-Electric Power Commission of Ontario, who gave an address entitled "Reminiscences", in which he described his experiences during a trip from Fort William to Winnipeg in the summer of 1874, before the railway was built. In closing, Mr. Maguire thanked the Northern Electric Company for having installed an address system which made it possible for speakers to be heard in every part of the dining-room, without effort.

The third session of the Convention was called to order at 9.55 a.m. on Friday, July 5.

Mr. G. L. Lillie, Engineer, Distribution Dept., Toronto Hydro-Electric System, read a paper entitled "Factors Governing the Design of 115–230 Volt Distribution at High Densities".

Mr. W. G. Hanna, Legal Dept., Hydro-Electric Power Commission of Ontario, gave an address on "Relations of Local Commissions". Mr. Hanna then answered a number of questions asked by delegates.

Mr. W. B. Smith on behalf of Mr. H. L. Summerlee, Burroughs Adding Machine Company, Detroit, Mich., read a paper entitled "Modern Billing Methods."

The Convention then adjourred.

At 12.30 p.m. the delegates met for the second Convention Luncheon when they were favoured with an address by Mr. Geo. D. Leacock, President, Moloney Electric Co. of Canada, Limited, Toronto.

The register shows that there were 348 delegates present at the Convention, classified as follows:

Class A	73
Class B	122
Associates	40
Commercial	80
Visitors	33
TOTAL	348

The hotel reported that there were over 570 present at the Convention Dinner.

R. M. Saxby, H.E.P.C. of Ont.

It is with regret that we record the passing of Robert M. Saxby, an employee of the Commission for over 20 years, who died at his home, No. 4 High Park Boulevard, Toronto on Friday, August 9, 1929.

"Bob." was born in Toronto on January 9, 1873 and received his education at Toronto schools and Boston Engineering School. For a number of years he was in the lumber business and operated a saw mill of which he was a part owner. In 1909 he came to the Commission and served during the early period of construction as inspector of wood pole and steel tower lines. Later he became purchasing agent for the Commission of all forest products, viz. poles, cross-arms, lumber etc. and was in charge of the Commission's pole yards.

As a result of the nature of his work, the manner in which he carried it out and his personality Mr. Saxby was known and respected from coast to coast, not only by executives of supply companies but by the men at the mills and in the woods. It was his custom each fall and winter to go through the timber limits about to supply poles and chose from the standing timber such trees as he judged fit for use. These

Field Staff on Transmission, Telephone and Relay Line Construction taken in 1910. Front row, left to right: E. F. Latimer and W. Hutchison, Inspectors, Telephone and Relay Lines; H. G. Acres, Transmission Line Engineer; R. Stott, Inspector, Telephone and Relay Lines; A. V. Trimble, Field Engineer, Transmission Line Construction. Back row: A. J. Campbell, A. T. C. (Mary) McMaster, W. A. Gordon, R. M. Saxby, G. G. Terry, H. Gee, Inspectors, Transmission Line Construction; A. C. Goodwin, Inspector of Cable; and T. U. Fairley, Field Engineer, Transmission Lines.

poles were again inspected before loading with the result that there were no rejections after delivery.

Mr. Saxby is survived by two sons, Fred and Frank. His wife predeceased him on Christmas day, 1928, and his father, a former employee of the Commission died about a week before him. The funeral was on Monday, August 12, to Park Lawn Cemetery, Toronto.

C. E. Reinke, Ancaster Twp.

Charles E. Reinke, a well-known resident of Ancaster and district for many years died on Saturday night July 27, 1929 after a lingering illness.

Mr. Reinke was born at Southcote in 1871 and for a number of years farmed at Ancaster, Westover and Bartonville. In 1914 he became Clerk of Ancaster Township and when Ancaster Hydro-Electric System commenced operation in 1920, was appointed secretary of the utility, which positions he held up to his death.

The funeral was held on Tuesday July 30, interment being made in St. Andrews Cemetery, Ancaster.

Mr. Reinke leaves, besides his widow, two sons and one daughter to whom we extend our sympathy in their loss.

Gatineau River Named After Early Trader

When Champlain in his ascent of the Ottawa river in 1613 reached what is now the site of the capital of the Dominion on June 4 he noticed a tributary coming from the north. The river was the Gatineau. Champlain gives no name to it and as far as the Geographic Board of Canada is aware the first record of any name for the river does not occur till 1783. In that year Lieut David Jones made a report. to Governor Haldimand on the suitability of land on the Ottawa for United Empire Loyalist settlement. In this he mentions coming "to the River Lettinoe (Gatineau) and from thence about a league to Shoadear (Chaudiere) Falls." At "River Lettinoe" the land "appeared to be good near the Bank of the Grand (Ottawa) River but Back full of marshes."

The river is not shown by name on any maps in the Geographic Board's collection till 1831. A plan of the Rideau canal by Col. By in that year shows "Gatteno River" as a short stream.

The name seems to commemorate Nicolas Gastineau or Gatineau of Three Rivers who engaged in the fur trade from 1650 till his death about 1683, with the Algonquins of the St. Maurice river.

Natural Resources, Canada.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Progress on Second 220 kv. Transmission Line from the Gatineau River

CONSTRUCTION of the second 220,000 volt transmission line from the Gatineau Power Co's plant at Paugan Falls, Quebec, to Toronto, has been progressing, since the early part of May of this year. This is in accordance with the programmme worked out in 1926, when the Gatineau Power Co. contract was signed, two circuits being decided upon at that time as the most economical for the transmission of the 260,000 h.p. available under the contract.

The westerly half of the line is being constructed at this time, from approximately the mid-point, near Bannockburn in Hastings County, to the terminus at the Toronto-Leaside Transformer Station.

This second circuit is being constructed generally parallel to the first, the circuits being spaced generally 150 feet apart. The design of the line has not been changed, the towers and conductor being exactly similar to those of the original circuit.

Progress in the construction has been practically up to the schedule set throughout the summer, the object being that the half-circuit will be completed by the first of October. Provision will then be made, by means of facilities for interconnection at the mid-point and at the transformer station, for the use of this circuit as an emergency circuit between these points, pending the completion of the remainder of the line.

In the immediate vicinity of the transformer station at Leaside, where the right-of-way is restricted, a new type of tower has been designed. The practice of separate single-circuit lines being followed in the open country is not permissible at this point, if the ultimate designed capacity of the Toronto-Leaside T.S. is realized. For this reason, a multi-circuit tower, resembling a bridge across the right-of-way, will be used, so that at least four 220,000 volt circuits may be carried on a 200 ft. right-of-way.

CONTENTS

Vol. XVI **No. 9**

September, 1929

	Page
Progress on Second 220 kv. Transmission Line from the Gatineau	305
New Semi-Outdoor Station in the Township of York - - -	306
Progress in the Use of Hydro and Cost of Service up to the End of 1928 - - - - - - -	308
Use of Hydro by Domestic Consumers Grows - - - - -	320
The Rubber Glove Situation - -	324
The Sense of Safety - - -	330
A.M.E.U. Notes - - - -	332
Hydro News Items - - - -	333

At the transformer station installation is nearing completion of two 25,000 kv-a. vertical synchronous condensers of outdoor type of construction. These machines will provide regulation of voltage at Toronto, necessary when such large blocks are transmitted such distances. The type of design is new, the combination of vertical units installed outdoors being, we believe, never before attempted. The design has been worked out by the engineers of the Commission in co-operation with those of the manufacturer, and the operation of these units will be watched with interest.

New Semi-Outdoor Station in the Township of York

A NEW semi-outdoor station has been installed for the purpose of serving power to portions of North York and Etobicoke Townships.

This station is located on property purchased by the H.E.P.C. from the C.N.R. in proximity to the Albion Park sub-division, approximately ¾ miles north of Weston on the Weston-Woodbridge road and consists of an outdoor structure for supporting the high-voltage equipment with two outdoor 300 kv-a., three-phase transformers together with a small brick building for housing the 4,000 volt switching equipment.

High Voltage Structure and Equipment

The outdoor structure is constructed entirely of 2 in. and 1¼ in. galvanized steel pipe and consists of four bays with all 2 in. uprights supported on concrete footings. One section is 6 ft. by 10 ft. and the other three sections 8 ft. by 10 ft. The first section is the 13,200 volt incoming line bay in which at present are choke coils and disconnecting fuses, also lightning arresters. It is so arranged that an oil breaker may be installed with the increase in transformer capacity.

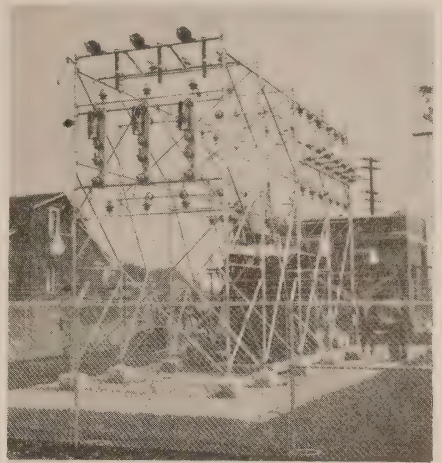
The other three sections are designed for a bank of 3-250 or 3-500 kv-a., single-phase transformers, but only two sections are used at present for the two 300 kv-a., 3 phase transformers. This structure supports all the 13,200 volt equipment, also the transformer neutral busses.

Low Voltage Building and Equipment

The low voltage switching equipment is housed in a one-story brick building 15 ft. wide by 21 ft. long and approximately 12 ft. high. In the building at present is switching equipment for the two 300 kv-a., 3 phase transformers and two 4,000 volt, outgoing feeders, one for North York Township and the other for Etobicoke Township, but space is available for three additional 4,000 volt feeders. Provision is made for an additional ten foot extension to the building when required, which will take care of equipment for two transformer banks and two 4,000 volt feeders. The switchboard and equipment is supported on 1¼ in. steel pipe. The main bus consists of 2 by ¼ in. copper bar on edge and provision is left for an emergency bus when required. The oil breakers are mounted on pipe framework and remote controlled from the switchboard.

Metering

Due to the fact that this station is serving two different rural power districts, there is no station totalizing equipment, but the load on each feeder is measured by a graphic recording wattmeter and reactive voltampere meter.



Albion Distributing Station from 13,200 volt end, Low Voltage Building in the rear

The switchboard, oil breakers, lightning arresters, current and potential transformers and bus supports, together with the 13,200 volt disconnecting fuses were supplied by the Canadian General Electric Co. The other main apparatus was manufactured by the Production and Service Department of the H.E.P.C.

The transformers consist of one 300 kv-a. 3 phase by Packard Electric Co. and one 300 kv-a. 3 phase by English Electric Co.

Progress in the Use and Cost of Service up to the End of 1928

By G. J. Mickler, B.A.Sc., Sales Department, H.E.P.C. of Ont.

THE progress in the development of Hydro as featured by the increase in the capital expenditure by the Commission and by the municipalities, as featured by the increase in the number and size of the water power developments, as featured by the increasing length and size of transmission lines or as featured by the increase in growth of the service to rural communities gives a profound impression of the success of an enterprise which is unique in the annals of service to mankind.

The ordinary individual is not interested to any great extent in the total capital expenditure, or the capacity, or the voltage of the service which he receives. He is far more concerned with the Dollars and Cents which he has to pay out at the end of each month for that service than anything else, and perhaps the most interesting feature of Hydro is the growth in the use of the service by different classes of consumers and the gradual reduction in the cost per unit of that service during the years in which Hydro has been serving in the Province of Ontario.

The Annual Report of the Hydro-Electric Power Commission as published contains figures on the revenues produced and the kilowatt hours consumed by the principal classes of service, namely :

Domestic Service,
Commercial Lighting Service,
Commercial Power Service,
Municipal Power Service,
Street Light Service,

and for the past few years these figures have been utilized to show in graphic form and otherwise what progress has been made in the use of Hydro service and how this use has affected the cost to the ultimate consumer. Continuing this practice the figures for 1928 as shown in the Annual Report and as produced from records of the Commission have been tabulated and graphically illustrated and present a most interesting picture of Hydro development.

The figures and illustrations which have been prepared are submitted in such a way as to give as complete a story as it is possible to give. In the case of Domestic and Commercial Lighting Service, the figures are divided up into four parts—those for municipalities or cities of 10,000 population or more—then figures for municipalities ranging between 2,000 and 10,000 population—these rank as towns—and then figures for municipalities or villages below 2,000 in population, with a summary totalling the previous three sub-divisions. These totals are submitted to show the number of municipalities served each year since 1914, the kilowatt-hours consumed, the number of customers served, the average cost per kilowatt-hour, the average monthly bill and the average monthly consumption. In the case of Commercial

TABLE No. I.

Data for Cities over 10,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	12	$ 614,925.00	12,646,400	55,597	4.86c.	$1.06	21.8
1917	19	1,063,264.00	36,693,100	107,248	2.89	0.88	30.5
1920	21	1,926,924.00	84,328,000	154,186	2.29	1.11	48.4
1923	21	3,772,416.00	206,266,200	223,028	1.83	1.53	83.5
1926	21	5,374,069.00	324,290,285	255,109	1.66	1.80	108.0
1927	24	6,086,753.11	371,945,485	276,632	1.63	1.87	114.4
1928	25	6,822,129.70	440,499,126	294,488	1.55	1.99	128.2

TABLE No. II.

Data for Towns over 2,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	19	$ 90,333.00	1,414,500	7,410	6.38c	$1.11	17.4
1917	27	180,375.00	3,824,600	15,731	4.71	1.01	21.4
1920	36	353,915.00	10,053,100	24,041	3.50	1.26	36.0
1923	43	651,499.00	25,411,300	34,135	2.56	1.57	60.1
1926	48	1,037,016.00	50,487,035	47,873	2.05	1.84	89.6
1927	56	1,325,096.89	62,105,723	56,813	2.13	1.99	92.9
1928	55	1,412,058.50	68,164,403	58,740	2.07	2.04	98.3

TABLE No. III.

Data for Villages under 2,000 Population
Domestic Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	18	$ 24,913.00	291,000	1,859	8.55c.	$1.10	13.1
1917	77	97,516.00	1,412,500	8,334	6.90	0.96	14.0
1920	109	233,819.00	3,829,900	15,665	6.00	1.29	21.2
1923	142	531,505.00	11,429,100	29,689	4.72	1.59	33.7
1926	174	942,309.00	29,945,632	46,900	3.15	1.71	54.4
1927	188	1,095,340.79	35,900,482	52,088	3.05	1.81	59.5
1928	188	1,177,624.28	42,346,506	54,783	2.80	1.84	66.0

TABLE No. IV.

All Municipalities Totalled
Domestic Service

Year	No. of Munici- palities	Annual Revenue	Kilowatt- hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump- tion Kw-hr.
1914	49	$ 730,168.00	14,359,100	64,866	5.08c.	$1.06	21.0
1917	123	1,340,855.00	41,930,200	131,313	3.20	0.91	28.6
1920	166	2,514,658.00	98,211,000	193,892	2.56	1.15	44.6
1923	206	4,955,420.00	242,926,600	286,852	2.04	1.54	75.7
1926	243	7,353,394.00	404,722,959	349,882	1.81	1.79	98.4
1927	267	8,497,190.79	469,851,690	387,573	1.80	1.87	103.5
1928	268	9,411,812.48	551,010,035	408,071	1.71	1.97	115.5

Power Service figures are included for all of the private companies served by the Hydro independent of the municipalities as well as the power consumers of all Hydro municipalities, but the totals do not include the surplus off-peak power under export. In the case of Municipal Power Service the tables include the revenue and consumption from such Municipal Services as Waterworks, Sewerage, Municipally-owned Railways or other Services for which the records were available. In some cases no kilowatt-hours were obtainable and for these municipalities the revenue corresponding has not been included in the figures. In all tables the kilowatt-hours consumed correspond to the revenue shown.

The general results of these tables show that the cost of power to Domestic and Commercial users for Ontario is ever on the decrease, while the rate of consumption is increasing year by year. They also show that the cost of power for municipal purposes is becoming less and less and that for ordinary industrial uses and for domestic, commercial and street lighting this is also the case.

In Table No. I are shown the figures for Domestic Service for 24 cities in steps of 3 years, from 1914 to 1926, and for the last 3 years as well—1926, 1927 and 1928, and this table shows that in 1928 there are 5½ times as many customers served as there were in 1914. The average cost per kilowatt-hour is less than ⅓ of what it was in 1914 and the average monthly consumption is over 6 times what it was 14 years ago.

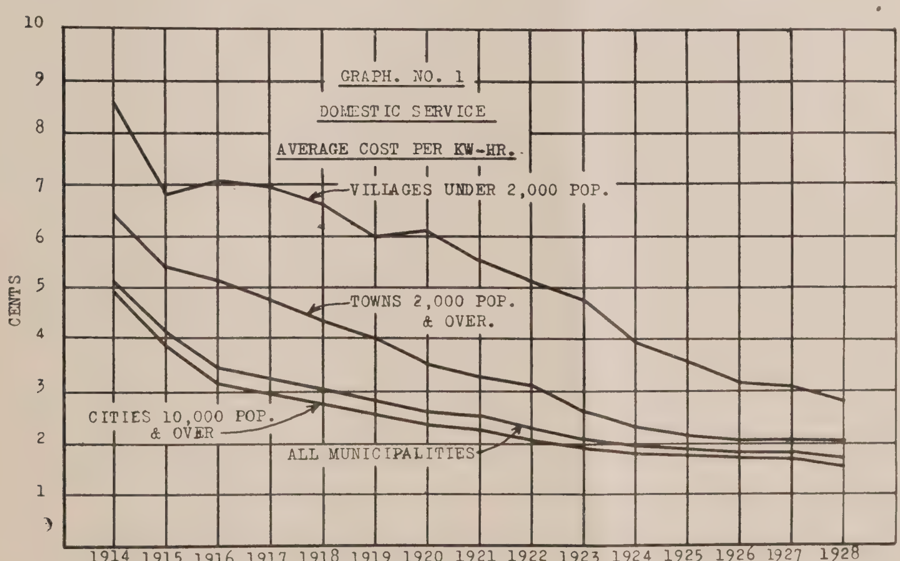
Table No. II covering towns, shows that the number of consumers is over 8 times in 1928 what it was in 1914; the average cost per kilowatt-hour is less than ⅓ what it was in 1914 and the average consumption is almost 6 times what it was 14 years ago.

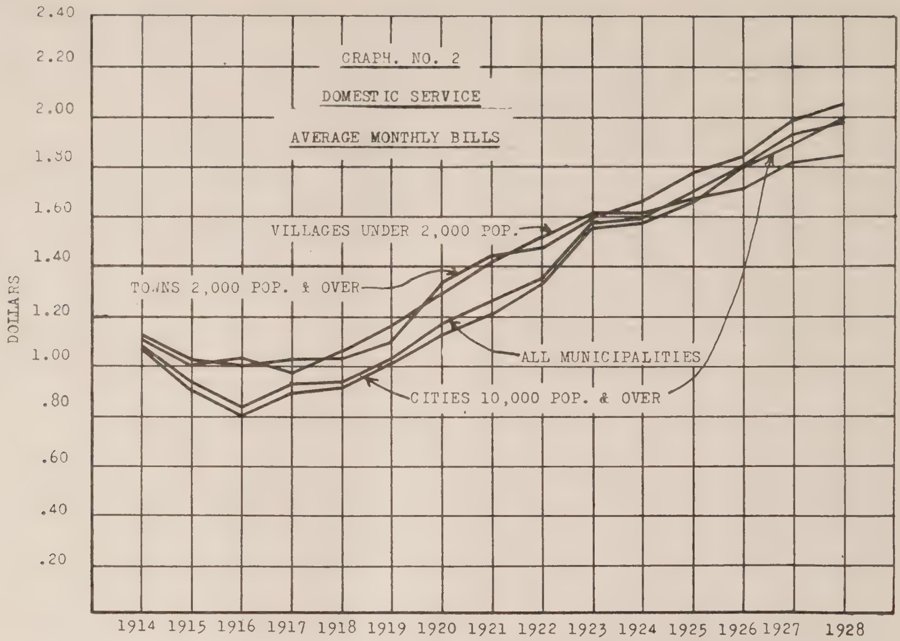
The same interesting features are contained in Table No. III for villages showing that we serve nearly 30 times as many customers now as in 1914. The average cost per kilowatt hour has come down from 8.55c. to 2.8c. and the average monthly consumption has gone up from 13.1 to 66 kilowatt-hours per month.

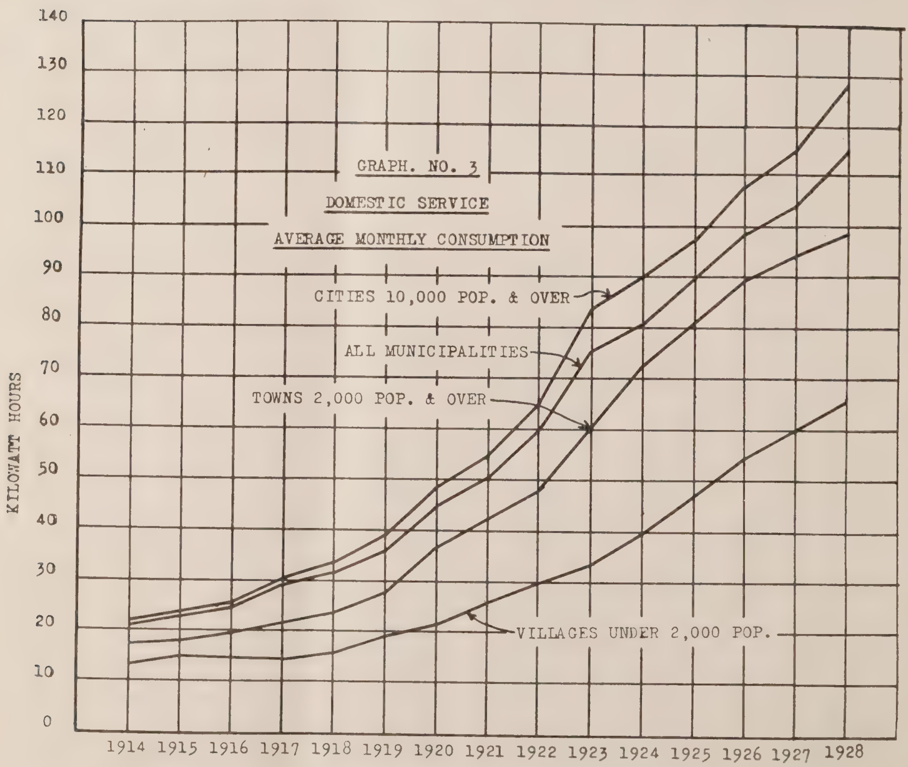
Table No. IV summarizing the results of Tables I, II and III shows an increase in number of municipalities

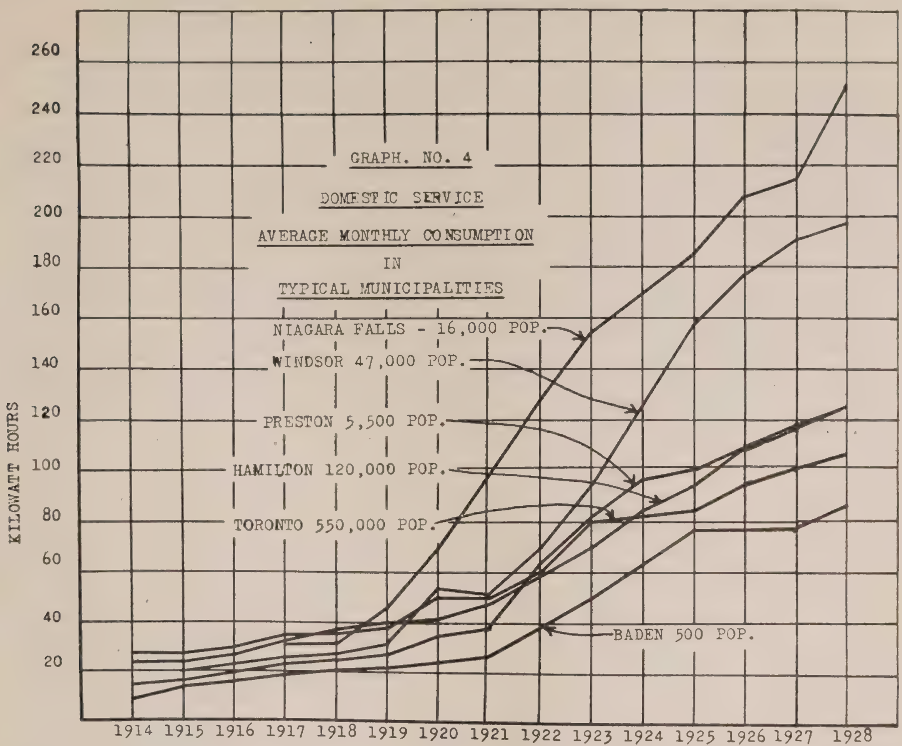
from 49 to 268, an increase in revenue from $730,168 to $9,411,812, or over 13 times, an increase in consumption of from 14,359,000 to over 551,000,000 kilowatt-hours, an increase in the number of consumers from approximately 65,000 to 408,000, a decrease in the average cost per kilowatt-hour of from 5.08c. to 1.71c., an increase in the average monthly bill of from $1.06 to $1.97 or about 90 per cent., whereas the average monthly consumption has increased from 21.0 kilowatt-hours to 115.5 kilowatt-hours or about 460 per cent. With an average consumption of 115.5 kilowatt-hours covering all municipalities in Ontario or an average of 1,386 kilowatt-hours per annum the average consumption in Ontario is more than 3 times as great as the average consumption among Domestic consumers in the United States. There are a great many municipalities in Ontario where the consumption is much higher than this average and indicate to what extent Hydro power might be used and also the effect on the rates or the average cost of such extensive use.

The 1928 Annual Report of the Commission tells us that in Niagara Falls the average consumption is 3,012 kilowatt-hours per annum and the average cost 1.1c. per kilowatt hour. Niagara Falls has increased during the past year by almost 600 kilowatt-hours per annum. Ottawa has an average annual consumption by domestic consumers of 2,772 kilowatt-hours, an average cost of 0.9c. per kilowatt-hour. Windsor has an average consumption of 2,256 kilowatt-hours, an average cost of 1.6c. per kilowatt-hour. Walkerville has an average consumption of 3,024 kilowatt-hours, an average cost of 1.5c. per kilowatt-hour. Waterloo has an average of 1,860 kilowatt-hours per annum and an average cost of 1.6c. per kilowatt-hour. St. Jacobs, a very small village less than 500 population, has an average yearly consumption of




GRAPH. NO. 2
DOMESTIC SERVICE
AVERAGE MONTHLY BILLS
VILLAGES UNDER 2,000 POP.
TOWNS 2,000 POP. & OVER
ALL MUNICIPALITIES
CITIES 10,000 POP. & OVER
DOLLARS
2.40
2.20
2.00
1.80
1.60
1.40
1.20
1.00
.80
.60
.40
.20
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928


GRAPH. NO. 3
DOMESTIC SERVICE
AVERAGE MONTHLY CONSUMPTION
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS 2,000 POP. & OVER
VILLAGES UNDER 2,000 POP.
KILOWATT HOURS
140
130
120
110
100
90
80
70
60
50
40
30
20
10
0
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928



1,224 kilowatt-hours and cost of 2.2c. per kilowatt-hour.

There are many other interesting examples of high consumptions and low average cost which the lack of space will not permit of publishing in this article, and they all reflect the effect of the increased use and the convenience of Hydro power. The consumption by domestic consumers in Ontario has increased during the past year alone from 469,851,000 to 551,000,000 or 81,160,000 kilowatt-hours—about 17 per cent. The increase between 1926 and 1927 was 15 per cent.

Graphically illustrated, the results of Tables I, II and III are shown in the following graphs :

Graph No. 1 shows the average cost per kilowatt-hour in 4 curves for municipalities 10,000 and over population; towns 2,000 and over population; villages 2,000 and under population and the fourth covering all municipalities.

Graph No. 2 shows the progress made in the amount of average monthly bills. The curves are again divided into the different classes as in Graph No. 1.

Graph No. 3 shows the average monthly consumption per consumer, and in nearly all cases, that is, in cities and towns and in the villages, the average monthly consumption has gone up during the year 1928 at an increasing rate over previous years.

Graph No. 4 shows the growth of consumption among the consumers of 6 typical municipalities from a

TABLE No. V.

Data for Cities over 10,000 Population
Commercial Lighting Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	12	$ 536,350.00	14,048,500	12,439	3.80c	$3.94	103.7
1917	19	642,989.00	27,479,800	19,573	2.34	2.96	126.6
1920	21	1,103,599.00	50,358,000	25,505	2.19	3.77	172.0
1923	21	2,043,197.00	91,146,500	32,016	2.25	5.56	246.9
1926	21	3,393,186.00	147,581,714	40,675	2.30	7.08	308.0
1927	24	3,844,501.17	169,213,258	43,702	2.27	7.49	329.2
1928	25	4,344,623.58	197,197,540	46,862	2.20	7.70	350.0

TABLE No. VI.

Data for Towns over 2,000 Population
Commercial Lighting Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	17	$ 71,457.00	1,362,000	2,393	5.25c.	$2.61	49.8
1917	27	134,730.00	3,100,600	4,107	4.35	2.76	63.5
1920	36	221,867.00	6,179,400	5,736	3.59	3.30	91.8
1923	43	315,530.00	9,598,000	7,086	3.29	3.76	114.3
1926	48	430,467.00	15,709,616	8,310	2.74	4.31	160.0
1927	56	560,479.40	20,372,460	10,054	2.79	4.79	172.3
1928	55	617,007.80	23,768,202	10,315	2.59	4.99	192.0

TABLE No. VII.

Data for Villages under 2,000 Population
Commercial Lighting Service

Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	14	$ 16,974.00	259,200	825	6.55c.	$1.74	26.6
1917	77	82,756.00	1,403,100	3,773	5.86	1.87	31.7
1920	109	152,497.00	2,799,500	5,255	5.89	2.45	45.0
1923	142	254,530.00	4,738,100	7,281	4.80	2.96	55.1
1926	173	352,942.00	8,505,684	9,459	4.15	3.22	77.7
1927	188	418,800.80	11,020,419	10,283	3.80	3.50	91.9
1928	188	475,163.71	13,561,089	10,836	3.54	3.65	104.2

TABLE No. VIII.

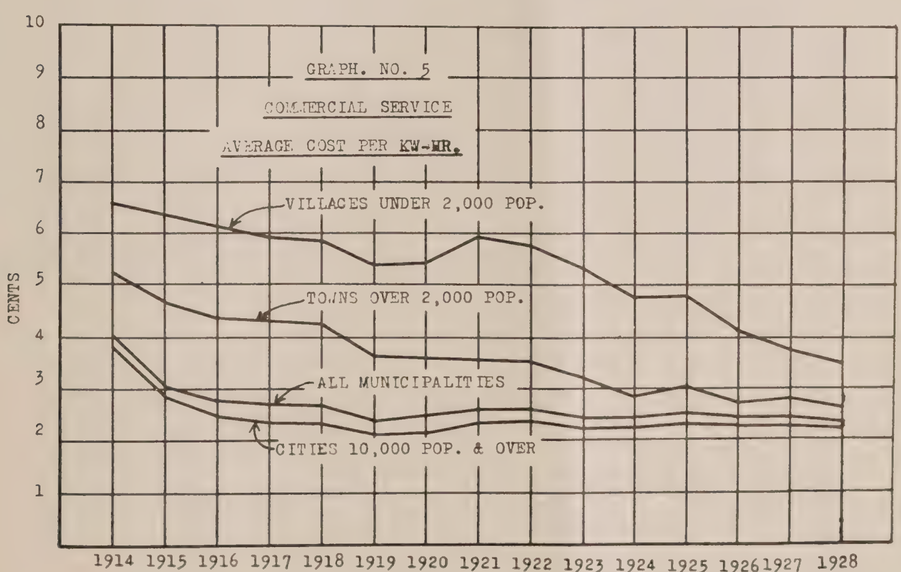
DATA FOR ALL MUNICIPALITIES TOTALLED
COMMERCIAL LIGHTING SERVICE

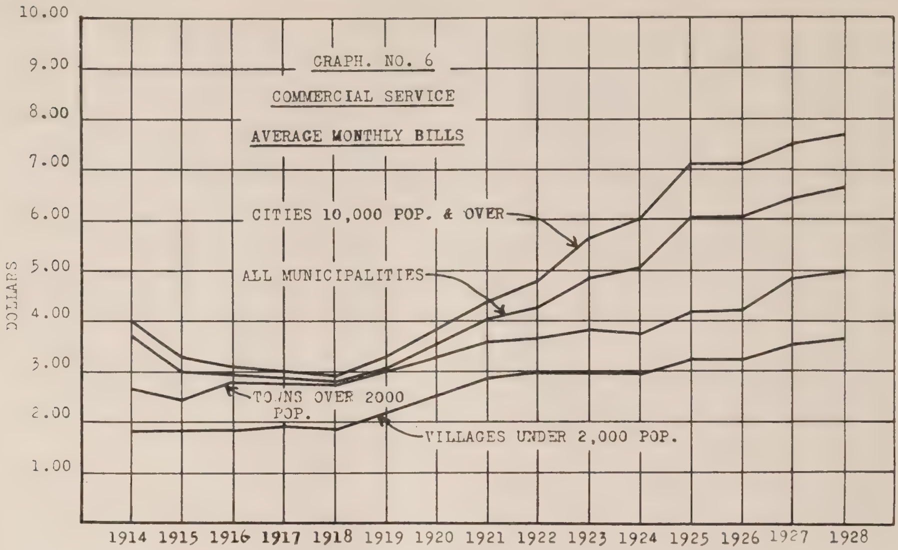
Year	No. of Munici-palities	Annual Revenue	Kilowatt-hours Consumed	Number of Consumers	Average Cost Per Kw-hr.	Average Monthly Bill	Average Monthly Consump-tion Kw-hr.
1914	43	$624,781.00	15,669,700	15,657	4.00c.	$3.63	90.8
1917	123	860,475.00	31,983,500	27,453	2.69	2.77	103.1
1920	166	1,477,963.00	59,336,900	36,496	2.50	3.51	140.0
1923	206	2,613,257.00	105,482,600	46,383	2.46	4.80	195.6
1926	242	4,176,595.00	171,797,014	58,444	2.43	6.08	250.0
1927	268	4,823,781.37	200,606,137	64,039	2.40	6.39	266.7
1928	268	5,436,795.09	234,526,831	68,013	2.32	6.66	287.4

small village up to the largest city served.

Tables No. V, VI, VII and VIII tabulate the figures for Commercial Lighting Service in the same way as the previous tables show the figures for Domestic Service and by observving Table No. VIII it will be seen that Commercial consumers have increased their revenue in the last 14 years from $624,781 to over $5,436,795, or almost 9 times. The consumption has risen from 15,669,000 to 234,527,000 kilowatt-hours. The number of consumers has risen from 15,657 to 68,013. The cost per kilowatt-hour has dropped from 4.00c. to 2.32c. The average monthly bill has risen from $3.63 to $6.66 due to an increase in consumption of 90.8 kilowatt-hours to 287.4 kilowatt-hours per month.

The results of these tables are further shown in Graphs No. 5, 6 and 7.




GRAPH. NO. 6
COMMERCIAL SERVICE
AVERAGE MONTHLY BILLS
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS OVER 2000 POP.
VILLAGES UNDER 2,000 POP.
DOLLARS
10.00
9.00
8.00
7.00
6.00
5.00
4.00
3.00
2.00
1.00
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928

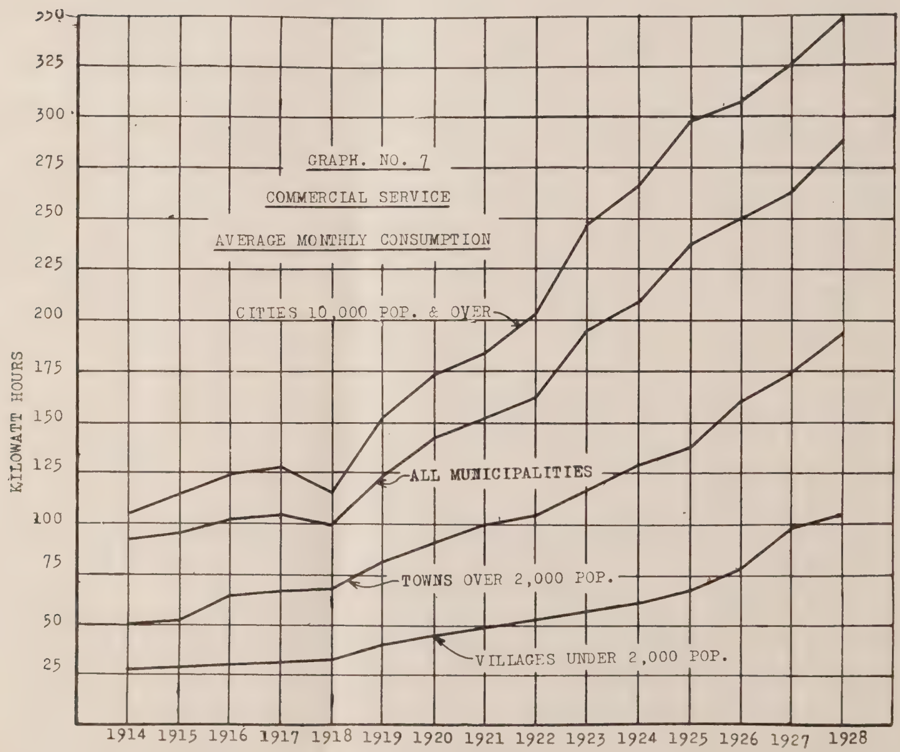

GRAPH. NO. 7
COMMERCIAL SERVICE
AVERAGE MONTHLY CONSUMPTION
CITIES 10,000 POP. & OVER
ALL MUNICIPALITIES
TOWNS OVER 2,000 POP.
VILLAGES UNDER 2,000 POP.
KILOWATT HOURS
325
300
275
250
225
200
175
150
125
100
75
50
25
1914 1915 1916 1917 1918 1919 1920 1921 1922 1923 1924 1925 1926 1927 1928

TABLE No. IX.

Data for all Municipalities and all Private Power Consumers of the H.E.P.C.

Commercial Power Service

Year	Number of Municipalities	Number of Private Companies	Revenue	Kilowatt-hours	Average Cost per Kw-hr.
1925	161	75	$ 9,896,881.98	1,734,409,666	0.59c.
1926	216	80	11,192,925.57	1,979,029,286	0.58
1927	245	78	12,064,818.02	2,033,491,298	0.58
1928	250	95	12,735,565.00	2,215,213,815	0.57

Note.—A slight correction was made in the figures for 1925, 1926 and 1927 upon checking the actual consumption for these years with interpolated figures.

Table No. IX shows the results of serving Power customers in municipalities and private customers served direct by the Hydro-Electric Power Commission. Insofar as the Commercial Power consumers in the municipalities are concerned the data include practically every power consumer in every Hydro municipality in the Province with very few exceptions, these latter being so small as to have no effect on the averages. Insofar as the Private Industrial consumers served direct by the Hydro-Electric Power Commission are concerned they include all of the companies receiving power direct from the Commission but do not include off-peak surplus power under export.

In arriving at the consumption of Industrial customers in most cases the kilowatt-hours were available from meter records. In some cases, however, the kilowatt-hours had to be interpolated from chart readings on a load factor basis and it is felt that the consumptions thus arrived at closely approximate the current consumed by the customers involved.

From the figures of Table No. IX it will be seen that the average cost of power for Industrial purposes for the year 1925 is 0.59c. per kilowatt-hour; for 1926, 0.58c. per kilowatt-hour; for 1927, 0.58c. per kilowatt-hour, and for 1928, 0.57c. per kilowatt-hour.

Table No. X shows the results for four years in connection with Municipal Power Service and gives an average cost per kilowatt-hour of 0.91c. It will be noticed that there

TABLE No. X.

Data for all Municipalities

Municipal Power Service

Year	Number of Municipalities	Revenue	Kilowatt-hours	Average Cost Per Kw-hr.
1925	27	$1,683,896.00	160,031,150	1.06c.
1926	84	1,895,607.96	177,362,002	1.06
1927	85	1,859,787.79	186,247,165	1.00
1928	120	1,920,149.00	211,171,026	0.91

TABLE No. XI.

Data for all Municipalities

Street Lighting Service

Year	Number of Municipalities	Wattage of Street Lamps in use	Assumed Annual Burning Hours	Kilowatt-Hours	Revenue	Average Cost per Kw-hr.
1925	244	15,100,000	4100	61,910,000	$1,414,382.00	2.28c.
1926	244	15,114,000	4100	61,967,000	1,457,687.00	2.35
1927	266	16,233,095	4100	66,555,689	1,559,965.00	2.34
1928	269	16,744,464	4100	68,652,302	1,560,420.00	2.27

are quite a number more municipalities included in this Table for 1928 than were included in 1927. The reason for this is that more municipalities have produced kilowatt-hour records of power consumed for municipal purposes than heretofore, thus making our records a little more complete.

Table No. XI gives a record of the use of power for street lighting purposes and shows an average cost per kilowatt-hour of 2.27c.

As mentioned in previous years this average rate of 2.27c. is higher than it would be if it were compared on the same basis as other services. That is to say, since the rates charged in the various municipalities for street lighting purposes include not only the cost of power and other operating expenses and fixed charges such as are borne by the other services, but also the cost of maintenance of the special equipment required for street lighting purposes as well as the interest, sinking fund and depreciation on this equipment and if we were to eliminate these costs the total street lighting revenue would be $1,086,000, which divided by the kilowatt-hours consumed will produce 1.59c. per kilowatt-hour.

Table No. XII is a summary of the data contained in Tables IV, VIII, IX, X and XI and is comparative for the years 1925, 1926, 1927 and 1928. A glance at this table shows that there has been an increase in the consumption between 1925 and 1928 of 830,311,293 kilowatt-hours or over 33⅓ per cent. by the consumers in Ontario with a corresponding increase in revenue of $7,798,501 with no apparent change in the average cost per kilowatt-hour. This may be explained by the fact that the relative proportions of low priced kilowatt-hours and high priced kilowatt-hours have not been maintained during this period.

The Annual Report of the Commission and the Tables presented above offer many more interesting examples of the success of Hydro in Ontario, but on account of the lack of space these cannot all be presented here. Nevertheless, it is gratifying to know that Hydro Service is spreading out among more and more consumers each year and greater use is being made of it by existing consumers with the result that the average cost is being lowered to the benefit of all.

TABLE No. XII

Total Data of all Services for the Past Four Years

Service	1925 Kilowatt Hours	1925 Revenue	1925 Avg. Cost Kw-hr.	1926 Kilowatt Hours	1926 Revenue	1926 Avg. Cost Kw-hr.	1927 Kilowatt Hours	1927 Revenue	1927 Avg. Cost Kw-hr.	1928 Kilowatt Hours	1928 Revenue	1928 Avg. Cost Kw-hr.
Domestic	342,356,700	$6,414,134	1.85c	404,722,959	$ 7,353,394	1.81c	469,851,690	$ 8,497,191	1.80c	551,010,035	$ 9,411,812	1.71c
Commercial Lighting	151,555,200	3,856,946	2.54	171,797,014	4,176,595	2.43	200,606,137	4,823,782	2.40	234,526,831	5,436,795	2.32
Commercial Power	1,734,409,666	9,896,882	0.59	1,979,029,286	11,192,926	0.58	2,033,491,298	12,064,818	0.58	2,215,213,815	12,735,565	0.57
Municipal Power	160,031,150	1,683,896	1.06	177,362,002	1,895,608	1.06	186,247,165	1,859,788	0.99	211,171,026	1,920,149	0.91
Street Lighting	61,910,000	1,414,382	2.28	61,967,000	1,457,687	2.35	65,613,550	1,559,965	2.37	68,652,302	1,560,420	2.27
Total	2,450,262,716	$23,266,240	0.95c	2,794,878,261	$26,076,210	0.93c	2,955,809,840	$28,805,544	0.97c	3,280,574,009	$31,064,741	0.95c

Note:—In all of the preceding Tables the figures showing kilowatt-hours represent the current sold to consumers of Hydro both Municipal and Provincial at the consumers' meters and the cost per kilowatt-hour as shown represents the cost of generation, transmission, transformation and distribution of current to the ultimate consumers located in the various municipalities. In some cases the point of distribution is over 250 miles from the generating plants and the distances from generating stations to points of distribution vary all the way up to this distance of 250 miles.

Engineering Fifty-two Years Ago.

From *Engineering News*, August 25, 1877

A Dr. C. W. Siemens, in England, estimates that the Falls of the Niagara do as much work in a year as 206,000,000 tons of coal at the rate of 4 lb. per horsepower in an hour. He considers that the Falls might drive an electrical machine, the current of which might traverse a copper rod. He asserts that a rod 3 in. in diameter would transmit 1,000 h.p. as far as 30 miles, and that at the end the electricity could be used to create motion or light. For the latter there would be sufficient to equal 250,000 candles.

Use of Hydro by Domestic Consumers Grows

By G. J. Mickler, B.A.Sc., Sales Department, H.E.P.C. of Ont.

DURING the past five or six years statistics have been collected from all of the municipalities served by the Hydro-Electric Power Commission of the number of major electrical appliances in use by the domestic electric consumers in these municipalities in an endeavour to find out to what extent the domestic users are making use of the advantages offered by cheap Hydro rates and an adequate power supply. The results of the surveys made each year have been tabulated and published from time to time in the Hydro BULLETIN and the results obtained have always shown that there is a steady growth in the number of the various appliances in use and also in the percentage saturation of the possible number which might be used.

Continuing the practice of the past the regular survey was made at the end of 1928 and the figures obtained are published herewith. For the sake of comparison the figures of the year 1924 and 1926 are submitted along with those of 1928 so that the progress in the last five years can be more easily observed.

Attention might be called to the saturation percentages for the years 1924 and 1928, showing that in—

- Electric ranges the saturation point rose from 13.8 to 23.1 per cent.
- Electric hot plates from 5.5. to 9.3. per cent.
- Electric washers from 15.8 to 25.9 per cent.
- Electric cleaners from 18.6 to 21.8 per cent.
- Electric water heaters from 4.8 to 9 per cent.
- Electric air heaters from 30 to 32.2 per cent.
- Electric ironers from 0.4 to 0.8 per cent.
- Electric irons from 89.2 to 89.9 per cent.
- Electric refrigerators from 0.2 to 3.9 per cent.
- Electric toasters from 44.1 to 47.0 per cent.

In the case of the larger current consuming appliances the saturation is almost double what it was five years ago and yet it is a long, long way from what is possible and what might be expected considering the rates and the other facilities that are offered for extending the use of these appliances.

Another feature of the tabulation is that in the four years—1924 to 1928—the estimated installed capacity of domestic appliances has risen from 806,901 kilowatts to 1,326,739 kilowatts, an increase of 519,839 kilowatts, or 695,830 h.p., and this growth alone is a very material contributor to the ever-increasing demand for power and for the development of more power resources in Ontario.

To give a little side-light on the extent to which electric ranges are being used in some municipalities a short table is submitted showing the number of domestic consumers at the end of 1928 and the number of electric ranges reported as being used by

TABULATION SHOWING THE NUMBER OF THE LARGER ELECTRICAL APPLIANCES REPORTED TO BE IN USE AMONG HYDRO DOMESTIC CONSUMERS IN ONTARIO AT THE END OF 1928 AND THE NUMBER CALCULATED TO BE IN USE DEDUCED FROM FIGURES REPORTED.* ALSO THE TOTALS ESTIMATED FOR 1924 AND 1926 FOR COMPARISON

	Estimated number in use Dec. 31, 1924, by 344,250 consumers	Per-centage Satura-tion	Estimated installed capacity Kw.	Estimated number in use Dec. 31, 1926, by 376,882 consumers	Per-centage Saturation	Estimated installed capacity Kw.	Number of munici-palities re-porting figures in 1928 out of 268	Number of wired homes re-presented by figures reported out of 414,139	Number of Appliances reported in use Dec. 31, 1928	Number calculated in use by 414,139 consumers	Per-centage Saturation	Estimated installed capacity Kw.
Electric Ranges	47,505	13.8	285,030	70,883	18.8	425,298	216	392,844	90,967	95,906	23.1	575,436
" Hot Plates	18,883	5.5	37,766	25,291	6.6	50,582	201	226,401	21,920	38,699	9.3	77,398
" Washers	55,342	15.8	11,068	78,063	20.7	15,612	211	177,131	55,640	107,370	25.9	21,474
" Cleaners	64,205	18.6	12,841	75,120	19.9	15,024	206	216,515	45,796	90,275	21.8	18,055
" Water Heaters	16,605	4.8	25,000	26,069	6.9	39,100	179	225,588	21,164	37,028	9.0	55,542
" Grates	15,075	4.4	30,150	16,812	4.4	33,624	156	227,719	9,277	17,620	4.3	35,240
" Air Heaters	103,000	30.0	82,400	106,125	28.0	84,820	182	189,611	64,181	149,900	36.2	119,920
" Ironers	1,590	0.4	4,770	2,255	0.6	6,765	112	190,020	1,294	3,045	0.8	9,135
" Irons	307,800	89.2	203,148	311,377	82.9	205,508	206	210,412	188,628	370,820	89.9	244,741
" Refrigerators	657	0.2	130	2,667	0.7	533	186	355,174	13,683	16,338	3.9	32,676
" Toasters	152,200	44.1	83,710	160,077	42.5	88,042	205	207,199	96,924	194,637	47.0	107,050
" Grills	46,800	13.8	30,888	42,000	11.2	27,720	173	168,457	20,124	45,262	10.9	29,872
Total			806,901 kw.			992,628 kw.						1,326,739 kw.
			1,081,640 h.p.			1,330,600 h.p.						1,778,470 h.p.

* In many instances estimates or actual figures showing the number of appliances in use were not supplied by municipalities. Estimates for these missing figures were supplied by averaging the figures which were received from other municipalities.

PARTIAL LIST OF MUNICIPALITIES IN ONTARIO SHOWING NUMBER OF DOMESTIC CONSUMERS AND NUMBER OF ELECTRIC RANGES REPORTED IN USE DECEMBER 31ST, 1928

Municipality	Number of Domestic Consumers Dec. 31, 1928	Number of Electric Ranges in use Dec. 31, 1928	Per cent. Saturation
Barrie	1,687	309	18.3
Belleville	2,847	576	19.9
Bowmanville	968	275	28.4
Brantford	6,075	2,200	36.2
Border Cities	24,944	18,769	75.2
Chatham	3,688	684	18.5
Exeter	427	107	25.0
Fort William	5,399	1,977	36.6
Galt	3,326	1,684	50.6
Guelph	4,763	681	14.3
Hamilton	28,892	7,445	25.8
Hanover	650	122	18.8
Kitchener	6,101	1,820	29.9
London	16,319	5,603	34.3
Midland	1,555	312	20.0
Mimico	1,524	560	36.7
Napanee	754	287	38.0
Niagara Falls	4,270	2,335	54.7
Oshawa	5,847	1,797	30.5
Ottawa	11,568	4,080	35.2
Palmerston	380	95	25.0
Preston	1,476	547	37.1
Queenston	61	37	60.6
Sarnia	4,324	1,154	26.7
Smiths Falls	1,574	252	16.0
St. Catharines	5,550	1,539	27.8
St. George	125	26	20.2
St. Marys	986	336	34.1
St. Thomas	4,041	940	23.3
Stamford	1,298	638	49.2
Stratford	4,180	2,216	53.1
Toronto	138,102	16,874	12.2
Waterloo	1,663	564	33.9
Woodstock	2,672	988	37.0
Welland	2,149	430	20.0
Weston	1,073	390	36.3

these consumers. This list is by no means complete but the municipalities were selected at random, large and small, scattered all over the Province, to give a general idea of the way in which Hydro customers are taking to electric cooking. In some cases the number of ranges is small because of natural or artificial gas competition which in a few instances is occasioned by the fact that the local Utility Commission operates both Gas and Electric Departments and naturally cooking by gas is advocated in these municipalities for the benefit of the Gas Department. In spite of this handicap in municipalities like Kitchener, Stratford, Guelph, Oshawa, St. Thomas and Waterloo there is a very healthy growth in the use of electric ranges and other appliances as well.

On account of the shortage of space it is not advisable to print the figures for all of the municipalities nor those on the use of other appliances and for the purposes of this article the totals as submitted in the table above are thought to be of most value.

In order to make a check on the total figures submitted by the municipalities at the end of 1928, an endeavour was made to secure from the manufacturers and importers of the various appliances tabulated a record of the number of their appliances which were being used by Hydro customers at the end of 1928. In some cases the manufacturers in their anxiety to co-operate with us in furthering the interests of the industry have submitted the necessary figures but in the majority of cases the manufacturers have withheld this information, making it impossible to arrive at the results which would have been of benefit to them and to the municipalities in general and would have rendered this survey perhaps a little more accurate. It was felt that as the figures submitted by many municipalities are based on estimates of various kinds a more accurate means of determining the number of appliances in use would be of value and until we can get the co-operation of all manufacturers a check of this kind will have to be postponed. Let it be said, however, that the estimates or figures submitted in the tables above are conservative and represent perhaps a smaller number of appliances in every case than what are actually in use and are intended in no way to bolster up the effect of Hydro service.

A further interesting feature of the growing increase in the use of electrical appliances by domestic consumers is the fact that the average use of the service by all consumers is increasing very rapidly. This is illustrated by the fact that in 1914 the average domestic consumer used 21 kilowatt-hours per month; in 1928 this had grown to 115.5 kilowatt-hours or 5½ times as much current is consumed by the average at the present time than was the case 14 years ago, and the average cost per kilowatt-hour for domestic service has been reduced from 5.08c. to 1.71c. per kilowatt hour and the cost is becoming less each year.

The Rubber Glove Situation

By F. M. Farmer, Chief Engineer, Electrical Testing Laboratories, New York

WHAT CONSTITUTES GOOD PRACTICE IN THE PURCHASING, CARE, USE AND TESTING OF RUBBER GLOVES?

THERE always has been a wide range of opinion on what constitutes good practice in the purchase, care, use and testing of rubber gloves. All will agree that the fundamental problem is one of affording maximum protection to men working on live circuits and apparatus. It may not be possible to insure absolute protection under all conditions but the greater the care and attention given to the problem, the more nearly will the ideal be attained. The problem then is the determination of what constitutes a reasonable amount of "care and attention." What procedures and precautions aid in increasing protection, what is the relative effectiveness of these various measures and, finally, what cost is justified?

Public opinion would certainly approve any cost which will be effective in reducing hazards to employees in a public service which involves an element of danger. It would seem, therefore, that a utility company is open to criticism if it is not doing all that can be done to protect its men. The use of rubber gloves is universally recognized as essential but there is a lack of uniformity of opinion as to just what measures are most effective in insuring the maximum protection.

Specifications.

Much progress has been made in recent years toward a general agreement on the essential requirements in a purchase specification for rubber gloves. Probably the most generally used specification, and therefore the one most nearly approaching a national standard, is that of the American Society for Testing Materials. This specification is the result of several years' experience with the problem by the Accident Prevention Committee of the National Electric Light Association previous to turning it over to the A.S.T.M. It was developed on the principle that they should contain a maximum of the performance type of requirements and a minimum of the manufacturing type of requirements.

In other words, the manufacturer under this type of specification is given as much freedom as possible, provided the product will meet tests which are designed to insure good service. Thus, in the A.S.T.M. specification, nothing is mentioned about the composition of the rubber, how the gloves shall be made or what method of curing shall be used. On the other hand various test requirements are included which common sense and experience indicate should insure those qualities which are believed desirable in good gloves. It was, however, necessary to include some details of a manufacturing character, such as certain inspectional requirements as additional precautionary measures, because despite all

the tests that are made we haven't complete confidence that they will insure an absolutely reliable product.

While the A.S.T.M. specification (or the essential requirements thereof) is probably used more than any other, there is not the general agreement that these should be for the best interests of the industry. Some engineers feel that more weight should be given to the electrical test and less to the visual inspection requirements; the argument being that if the gloves pass a severe electrical test imperfections of a visual character are of no practical significance. Others argue that too high an electrical test will partially damage the glove, or that it is not an infallable insurance of electrical reliability when in service because of the difference between service conditions and test conditions and that therefore it should be supplemented by all other reasonable precautionary measures such as elimination of surface imperfections, thin spots, etc., which may be potential sources of weakness. Then there are the controversial points which are important from a simplification standpoint, such as the proper length of glove, the uses of two classes in the industry, the use of an outer protecting glove, etc.

Controversial Points

As to controversial matters of the first kind, the criterion should simply be that which provides the greatest insurance to the prospective wearer. It must be remembered that when in use, gloves are being manipulated so that the rubber may be under tension at certain places and under compression at others. Thus the state of the rubber in the different parts of the glove is different from that existing when subjected to the standard acceptance voltage test. Therefore, the voltage test should be as high as feasible and applied for a sufficiently long time to develop any electrical weakness as much as possible, and then supplement the test with the elimination of any visible conditions in the gloves which introduce any hazard under conditions of use.

In regard to the second group of controversial matters, there does not appear to be any good reason why the industry should not agree upon one standard in these matters for the sake of the advantages accruing from manufacturing simplification. For example, it is difficult to see why more than one length of glove should be used. Also, it does not appear that there are differences in requirements of the industry sufficient to justify two classes of gloves. One class should be eliminated in the interest of simplification, economy and general betterment of the production problem.

One of the most important controversial points is the present limitation of the application of gloves to circuits not exceeding 3,000 volts to ground. The practice of permitting men to work on live circuits at voltages in excess of 3,000 volts to ground is apparently growing and presumably the exigencies incident to the development of the business will be alleged to require working on live circuits at continually increasing voltages. This raises the question of what should be the margin between the voltage at which the gloves are tested and that at which they are

used? Also, with a given margin, what determines the limiting voltage at which gloves should be used?

A.S.T.M. Requirements

The A.S.T.M. requirement corresponds to a factor of the order of 5 so far as dielectric strength is concerned. Considering that this is under test conditions where the glove is under no mechanical stress, and that a factor of 2.5 or 3 is required in most electrical equipment where no human hazard is involved, it would seem that a factor of 5 under the test conditions is small enough. However, the leakage current is likely to be the limiting factor because the permissible value is a fixed quantity irrespective of the voltage. The A.S.T.M. limit of 10 milliamperes at 10,000 volts under the prescribed test conditions was fixed on the basis of actual studies of current which would cause mild electric shock under the conditions of use. If, therefore, gloves are to be used at 5,000 volts, for example, the breakdown voltage should not be less than 25,000 volts and the leakage current should not exceed about 0.6 milliampere per thousand volts. In other words, the electrical impedance of a glove should be increased not less than in proportion to the voltage at which it is proposed to use it.

While, theoretically, equal protection is afforded if the breakdown voltage and the impedance of the gloves are increased in proportion to the voltage, thought should be given to the well known marked effect of electrical stress on rubber in air when the stress gradient in the air approaches the ionization stress, particuarly where the rubber is also under any mechanical stress. These conditions may be encountered in local regions in the actual use of gloves where, because of relatively sharp corners of metal parts, for example, the electrical stress gradient may be high and where the glove may be under considerable mechanical distortion at the same time.

Care and Use

Gloves having been purchased under a reliable specification and thoroughly inspected and tested to insure compliance therewith, precaution still should be taken to see that they are stored properly, effectively protected from injury when not in use and that they are properly used by the workmen.

The Accident Prevention Committee has recommended on numerous occasions desirable standard practices covering these matters. Suffice it to indicate that gloves should be stored where they will reasonably dry, protected from light and where the temperature will not exceed 90 degrees F. After inspection and testing each pair of satisfactory gloves should be placed in a sealed package bearing the date of inspection and test and issued in this way to the user so that his confidence in the condition of the gloves will be assured.

It is obviously important to protect the gloves from mechanical injury between periods of actual use. This is easily provided for in the storeroom but in the field special provision is desirable in the form of metal or wooden boxes.

The importance cannot be over emphasized of seeing to it that when

in actual use, the limitations of gloves are fully recognized and that men use them accordingly. Written instructions should be provided but the foreman should be responsible for making sure that these instructions are being obeyed. Such instructions have been recommended by the Accident Prevention Committee, N.E.L.A., and need not be discussed here.

The proper methods and technique in the testing of rubber gloves have been fairly well standardized. The generally accepted method of making voltage tests, namely, by filling the gloves with water and immersing them in water is obviously a compromise. The "electrode" conditions when a glove is in use are so variable and uncertain that a standard condition which actually duplicates working conditions is not practicable. The best that can be done therefore, is to test the gloves so that the entire surface on both sides is in contact with the electrode and is moist. Complete immersion in water is the simplest and most effective way of attaining this condition.

Mechanical Stress In Use

In use a glove is subjected to more or less mechanical stress which varies in amount throughout the glove. It has at times been proposed, therefore, that the electrical test should include something of this element. Applying air pressure above the water inside the glove thus distending it more or less uniformly, or putting lead shot in the suspended glove thus producing more or less unequal distortion of the glove, are schemes which have been used. It has, however, never been demonstrated that these added details make the test more effective.

There has been a more or less prevalent idea that the water in which gloves are immersed in the high voltage test should be salted in order to develop the maximum leakage current. That this is unnecessary is obvious when it is considered that the impedance of a normal glove is of the order of 1,000,000 ohms and that the power factor is of the order of 2 per cent. A change in the resistance of the circuit of several thousand ohms—far more than that between different kinds of water—is completely masked by the capacitance impedance and cannot have any appreciable effect on the leakage current. The following actual measurements confirm this contention:

	Current at 10,000 Volts 60 cycles (Milliamps)	
	City Water	Salt Water*
Glove No. 1.	6.2	6.2
Glove No. 2.	6.6	6.7
Glove No. 3.	6.6	6.4
Glove No. 4.	7.8	7.8
Glove No. 5.	9.2	9.2
Approx. Spec. res. of water, ohm-cm.....	4000	3.5

* 2 per cent. salt by weight.

The relative importance of the voltage applied and the time of application is an outstanding controversial question in high voltage tests of all kinds of insulation. Rubber gloves are no exception.

The writer is of the opinion that a voltage test for gloves intended to be used at not over 3,000 volts should never be less than 10,000 volts for

either new or old gloves and that the time should never be less than three minutes. A test of 10,000 volts provides a factor which is none too large in view of the lack of control over the uniformity of the product, not only when new but particularly after having been in service. As to the time, the short time test is about as effective as a long time one in eliminating defects of a strictly mechanical character but time is required to develop electrically weak spots into failures. It may be argued that such defects usually develop into failures through the generation of heat at the defect but that with water electrodes such heat is carried away and therefore, the longer test does not accomplish anything. While doubtless the water electrodes do reduce the effect of the time element, nevertheless it is believed that one minute, as advocated by some, is much too short a test period.

How Much Leakage is Safe ?

The importance of the so-called leakage current has not always been conceded but it is now generally recognized. No insulation that can be imposed between the workman and a live circuit can be so high that no current whatever will flow through him. Naturally the current that will flow will be greatly affected by other factors than the gloves. For example, if a man were working on a dry wood pole, its resistance might be so high that even with very "leaky" gloves the current would not be objectionable while with a wet or green wood pole or with a steel pole the current might be dangerous. But it is generally agreed that the "series resistance" should be taken as zero and sole reliance placed on the gloves. The question is therefore, how much current may be permitted without being hazardous.

If data of the kind indicated were collected in a sufficiently representative quantity, it ought to be possible to establish all of the details of what constitutes good practice in the matter of rubber gloves. Further, it should always be possible to know how much improvement is being made and in what directions further improvement is possible, not only in the gloves themselves but in their use.

There are, of course, differences of opinion on what should determine this maximum value. Certainly the most conservative value is the maximum current that will NOT cause an involuntary muscular reaction which, while perfectly harmless in itself, might cause a sudden involuntary movement resulting in an injury. A recent investigation of the amount of 60-cycle current which will produce mild shock disclosed that the average of the currents at which 42 men first observed the sensation of stock on sudden contact was 1.2 milliamperes and the average of the maximum currents which the men could withstand without serious discomfort was 8.0 milliamperes. In actual use, the amount of current which will flow will depend upon the area and condition of contact between the glove and the "live" circuit, and that between the glove and the wearer's hand. Certainly the standard test condition under which gloves are tested (*i.e.*, gloves filled with water and immersed in water) allows at least two to three times as much current to flow

as any condition which would be encountered in use. Therefore, the standard limit of one milliampere per 1,000 volts under the test condition would seem to be conservatively safe.

No glove should be tested without provision for determining that the leakage current is safe. High accuracy is not essential—within 10 per cent is sufficient. As to whether this current should always be measured at the end of the test period, experience does not show any change with time if the current is at all reasonable (*i.e.*, within the specified limit). However, if the current is abnormally high, it is likely to increase with time.

Periodic Testing of Gloves

This is a feature of the glove situation about which there is a very wide difference of opinion and of practice. On the one hand, there is the policy of making no periodic voltage tests whatever of gloves which are in service, depending entirely upon the inspection made by the men each time before they use the glove; the argument being that this places the responsibility upon the wearer himself. On the other hand, there is the view that electrical tests give greater assurance of reliability than the most careful visual inspection.

Both contentions, of course, can be supported by reasonable argument. For instance, a glove may pass a high voltage test and still have a visible scratch or cut that might develop into an actual hole in a few minutes of splicing service. On the other hand, a glove with a high leakage current that would give a man a "surprise" shock or a glove with a low electrical strength will often pass a most rigid visual inspection. Under these circumstances, it would seem obvious that the responsibility of the utility company would require that both careful inspection and careful testing are essential in keeping the potential hazard at a minimum.

Conclusions

One of the causes of variety of views on the glove problem is the lack of reliable data. Most controversies are the result of differences of opinion which, in too many cases, are not substantiated by concrete evidence of a reliable character. The systematic collection and analysis of complete records of the initial inspection and test data on a sufficiently large number of gloves to represent the entire industry would provide a continuous picture of initial glove quality. But what is more important is concrete evidence of the service which gloves give. This could be obtained by following each of a sufficiently large number of gloves through its life and keeping a complete record of its history, including such matters as the reinspection findings, the re-test data, the kind of service, actual number of hours worn and by whom, number of times issued, method of cleaning if any, reason for finally discarding, etc.

Analyses of these two general classes of data which had been systematically obtained on a sufficiently large scale should yield definite and concrete answers to such questions as the following:

1. Is there a real need for the two classes of gloves now used in the industry, and, if so, why?

2. Are so-called surface defects being given too much attention and

can the electrical test be taken as the sole criterion ?

3. If surface defects are a hazard, or may become so under the conditions of use, what concrete reproducible standard for acceptability can be set up ? (Perhaps a method of making gloves will be devised which will result in an absolutely uniform product, so far as appearance is concerned ; but certainly at the present time this matter of so-called surface defects is one of the most troublesome factors in the acceptance inspection of gloves).

4. Just how effective are gloves as a protection ? In other words, how many minor and major failures of gloves, to afford complete protection, occur per year in terms of the total number of gloves in actual use ?

5. Are or are not gloves improving as to the protection being afforded ?

In conjunction with the systematic collection of these routine data, systematic investigations should be made from time to time of such matters as the effect of age on electrical strength, leakage current, mechanical strength and flexibility.

—*National Safety News.*

The Sense of Safety

The world has long been satisfied to accept the belief that we are possessed of five senses, namely, sight, hearing, taste, touch and smell. True it is that if we blindfold a standing person and place in one of his hands a half pound weight and in the other a pound weight, irrespective of the size of each weight, that that person immediately and accurately can determine the heavier and it is certainly not determined by sight, hearing, taste, touch or smell. Anatomists tell us that this is because we possess muscular sense.

Now let us consider the matter of our senses from a safety standpoint. The five senses enumerated above all act as warning senses, for it is through the functioning of our eyes, ears, mouth, nerves (through touch) and nostrils that we are able to apprehend danger. While these senses inform us and warn us of danger, they are not capable of protecting us against the impending danger. We see with our eyes an approaching automobile at a terrific speed, but seeing the automobile is not getting out of the way of danger. We hear the bell of the approaching locomotive but that does not place us in a position of safety, and so it is with all the other senses. What does safeguard us in the presence of danger is our safety sense—a sense which acts, for, in nearly every case of danger, the remedy is found in quick action.

This sense of safety or preservation is after all probably more important to our life, happiness, and enjoyment than any other sense because upon its functioning may depend our very life. Moreover, the safety sense is not an organic sense; it does not depend upon a specific organ such as sight, which depends upon the functioning of our eyes alone or our sense of hearing which is the function of our ears, or the sense of taste which

we derive from the tongue. Should any defect occur with these organs of sense, that sense may be partially or wholly destroyed, such as blindness, deafness, etc., etc.

The safety sense depends upon our prompt safety action after the other sense or senses have carried the message of danger to our brain, which in turn should immediately cause the right action on our part to prevent our injury from the threatening danger.

We are all familiar with the common practice of a person instantly closing his eyes when threatened with eye injury from some small substance or particle approaching the eyes. This closing of the eyelids is the safety or preserving sense. A sleeping person, without waking, will slowly move the foot away in the presence of the irritation of tickling. The reason for this is that subconsciously the irritating sensation is a warning that there is something going on which might mean danger and so the foot is slowly withdrawn.

We must all realize that we have this safety sense and that it is ever ready to function, never tires, does not depend upon any one specific organ, but it is the exercising and functioning of this safety sense which gives us the rich reward of preserving us from accidental injury.

We should use our safety sense as much as we do our other senses. Consider the use we make of our eyes; day by day and year by year some sixteen hours a day of ceaseless service. We have a safety sense for a very vital reason. We should use it all the time.—*Safety Engineering.*

Objections to Overhead Wires

We are glad to see that the Central Electricity Board have been firm about the tower line over the South Downs. "Preservation of the South Downs", they say, "must give way to national necessity and benefit." Of course, when the *cliché* of "spoiling the amenities of the lovely countryside" does not hold good, any old argument that is available may be used; no pole line must go up without a stiff fight. For instance, a much smaller pole line is proposed by the Leicestershire and Warwickshire E.P. Company between Oakthorpe and Donisthorpe. Sir John Turner opposed this on the ground that it would spoil his partridge shooting. One can quite understand that if some fool of a partridge, in hustling to escape, banged against the wires and broke its collar bone, this might rob Sir John of a magnificent left and right. But during the inquiry some doubt was thrown on the prevalence of partridges in this area and no evidence was available. Whereupon it was suggested that there were also hares to be shot. It would be interesting to know whether the British hare is in the habit of climbing poles and walking along tight ropes. But even if he is, would not this improve the shooting of Sir John ?

The Electrical Times.

Reynolds—Birch

We announce the marriage of Mr. R. S. Reynolds, Manager, Chatham Public Utilities Commission, to Miss Dorothy Birch, of Chatham, on September 4, 1929. Prior to coming to the Chatham Commission, Mr. Reynolds was Superintendent of Chatham Rural Power District. He is an honour graduate of Queen's University in Mechanical and Electrical Engineering, and has distinguished himself as a player of Rugby, Baseball and Hockey.

Our congratulations are extended to Mr. and Mrs. Reynolds, with every good wish for the future.

Association of Municipal Electrical Utilities

Minutes of Executive Committee Meeting

A meeting of the Executive Committee of the A.M.E.U. was held at the office of the Hydro-Electric Power Commission of Ontario on the morning of Thursday, September 5th, beginning at 10.15 o'clock. The following committee members were present :—Messrs. A. W. J. Stewart, President, R. H. Starr, R. L. Dobbin, A. L. Farquharson, J. G. Archibald, J. E. B. Phelps, and S. R. A. Clement.

It was moved by Mr. R. H. Starr and seconded by Mr. J. E. B. Phelps that the minutes of the last Executive Committee meeting as published in the BULLETIN, to be taken as read. —Carried. The Secretary then read correspondence received from the Royal York Hotel in reference to the facilities offered for the Winter Convention.

It was moved by Mr. J. G. Archibald and seconded by Mr. R. H. Starr, that the Winter Convention of the Association be held at the Royal York Hotel on January 29th and 30th, 1930.—Carried.

Mr. T. C. James, President of the Toronto Electric Club, having been asked to be present, details were discussed regarding having the Electric Club attend the Association luncheon on January 29th.

It was suggested that at the Convention dinner, musical entertainment be provided and the Secretary was instructed to communicate with Mr. Hannigan, Secretary of the O.M.E.A., suggesting that his Association obtain speakers for the two luncheons only.

Moved by Mr. R. H. Starr and seconded by Mr. J. G. Archibald that the Convention Committee arrange with Mr. Chas. Musgrave to provide for entertainment for the Convention dinner, and music for the two luncheons, at a cost of approximately $200.00.

Suggestions were given regarding papers for the Convention, which the Secretary was asked to forward to Mr. Scott, Chairman of the Papers Committee, together with instructions as to the number of papers that will be required.

There being no further business the meeting then adjourned.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

Hydro News Items

Central Ontario System

One 1500 kv-a., 3-phase transformer is to be installed in the Kingston substation in place of one of the four 750 kv-a., 3-phase transformers.

* * * *

Georgian Bay System

Tenders are being called for on two new 1,000 kv-a. transformers for the Barrie substation, and arrangements are being made to complete the installation this Fall.

* * * *

The new terminal grain elevator at Collingwood has been completed and is now taking service from the local Commission. Power is delivered and taken at 22,000 volts, and the demand will vary between 300 and 400 h.p.

* * * *

The new development at Tretheway Falls on the south branch of the Muskoka River has been completed and all equipment is now being tested preparatory to placing same in operation at an early date. This development will give the Commission an additional 2,300 h.p. for the Georgian Bay System. The generating station is semi-automatic and will form part of the Muskoka Development, being controlled from the main switchboard of the latter. A complete description of this plant will appear in a later edition of the BULLETIN.

* * * *

The Commission has authorized the construction of a 110 kv. transmission line between Kitchener and Hanover, and the installation of a 5,000 kv-a. frequency changer set to be located at Hanover. The installation of a new unit at Eugenia has also been authorized. The construction of this new line and station, and the new unit at Eugenia will be undertaken so as to be ready for operation by the Fall of 1930. To provide for 1929 conditions in the Eugenia district a 1500 kv-a. synchronous condenser, together with two 1500 kv-a. auto transformers are being installed at the Eugenia Power House, which will make possible the transfer of larger blocks of power from the other developments of the Georgian Bay System into the Eugenia area at peak load periods.

* * * *

Considerable activity is being manifested in connection with rural service, and the following extensions have been authorized and approved by the Commission, the construction of which will be undertaken and completed this Fall, and these new lines placed in operation :—

Essa and Tossorontio townships in Alliston Rural Power District—8.25 miles of new line to be constructed with service given to 37 new consumers, including the Police Village of Everett and farms adjacent thereto, the largest customer being the Loblaw farm.

Scugog and Cartwright townships in Port Perry Rural Power District—13.2 miles of new line with service given to 67 new consumers, principally in the vicinity of Ceasarea.

Brock and Scott townships in Uxbridge Rural Power District—12.5 miles of new line with service given to 31 new consumers.

Reach township in Mariposa Rural Power District—6.8 miles of new line with service to 18 new consumers.

* * * *

Niagara System

Rural extensions in Niagara district, which have been brought under construction since the last report published in this section, cover a total of approximately 150 miles of primary lines to serve 616 consumers.

* * * *

Owing to increased load it has been found necessary to increase the capacity of the Dundas distributing station which serves the Dundas and a portion of Lynden Rural Power Districts. Three 250 kv-a. transformers are being installed in place of the existing 3 150 kv-a. transformers.

* * * *

The ornamental street lighting system in Ridgetown has been changed from series to multiple operation. The original installation consisted of 18-400 c.p., 6.6 ampere, series lamps in cast iron standards, and was installed 14 years ago. These were served from a single conductor, lead covered, armoured cable laid in the roadway of the main street, which at that time was not paved. Last summer the business men decided to increase the amount of lighting on this main street and as the constant current transformer serving the whole town was already fully loaded, it was decided to change the ornamental lighting from series to multiple. The development of the gas-filled high efficiency multiple lamps since the time of the original installation was also a factor in deciding to make the change. The original lead covered cable carries power to this street lighting, the lead sheath of the cable being used as the grounded conductor. The power is taken from the present house lighting transformers through relays operated by the present series street lighting system. The change also necessitated replacing the heads and glassware, and 500-watt multiple lamps have been installed in each standard. It is expected that by the change, the cost of maintenance will be reduced and repairs can be more easily effected, while the street lighting will be more efficient and of modern appearance.

* * * *

The Ambassador suspension bridge which spans the Detroit River from the town of Sandwich, Ontario, to Detroit, Michigan, has the electrical equipment installed, and service will be supplied by the Sandwich Hydro-Electric System and the Detroit Edison Company. The service on the Canadian side will be supplied through a lead-covered, underground cable at 4000-volts, controlled by a three-phase, automatic oil switch in the building. In the transformer vault in the same building are installed two 100 kv-a., 2200/110-220 volt, 25-cycle, pole-type transformers, and two 50 kw. constant current series street lighting

regulators, 20 ampere secondary. One 100 kv-a. transformer and one 50 kw. constant current regulator will be connected to each of the three phases. The other regulator is a spare, and will be immediately thrown on the line in case of trouble by the double-throw oil switch which has been provided with this equipment.

The series lighting, by means of 600 candle-power, and 400 candle-power lamps, 20 ampere, will light the approaches and the bridge proper. The downstream side, including that side of the Canadian and U.S. approach, will be lighted by the Sandwich Hydro, and the upstream side by Detroit Edison.

On the Canadian side is to be the office building, lighted by 110-volt multiple lamps, two separate 110-220 volt circuits being installed, one from each transformer.

The motors are 220 volt, single-phase, a 5 h.p. motor handling the ventilating fan and a 10 h.p. the compressor for the pneumatic tube system which connects the main office with the booths or islands out on the bridge, where the Customs and Immigration officials are stationed. These islands are twelve in number, and each one is equipped with two 6 kw. electric air heaters.

On the U.S. side a 200 kv-a. single phase, 4600/110-220 volt transformer is installed along with the constant current regulator. The islands are smaller here so that each has two 3 kw. air heaters installed. The remainder of the equipment is the same as that on the Canadian side. The bridge will be opened for traffic Dec. 1st, 1929.

Rideau System

Increases in load make necessary larger station transformer capacity at the following points :

Perth : One 750 kv-a., 3-phase transformer is being installed in place of three 200 kv-a., single-phase transformers.

Kemptville : One 300 kv-a., 3-phase transformer has been placed in service, replacing one 150 kv-a., 3-phase transformer.

Carleton Place : It is planned to add three 200 kv-a., single-phase transformers to this station, in addition to the three 250 kv-a., single-phase transformers now in use.

Smiths Falls : This station was enlarged in 1927, by adding a second 750 kv-a., 3-phase transformer.

* * * *

St. Lawrence System

The transmission line between Smiths Falls transformer station and Brockville, is being reinsulated to permit operating at 110,000 volts in place of 44,000 volts. The higher voltage will soon be required to take care of increased load on the St. Lawrence System. It will also be necessary to install transformers to connect the 110,000 volt line to the 44,000 volt line of the St. Lawrence System.

Arrangements are being made to install a 1500 kv-a. 3 phase transformer in the Brockville substation to take the place of one of the two 750 kv-a., 3-phase transformers now in use.

* * * *

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Large Gravel Plant Operated by Hydro-Electric Power.

By W. W. Southam, Sarnia Hydro-Electric System

ONE of the most modern gravel plants is operated at Sarnia, Ontario. The material produced at this plant is handled entirely by machinery operated by hydro-electric power, with the exception of two steam locomotives which transport the material from the pits to the plant.

Power is delivered by means of a 26,400 volt line and is supplied to the plant through a small sub-station consisting of three 250 kv-a. transformers which step the voltage down to 575 volts. Two 550 volt feeder panels and oil breakers take care of the two low tension feeders, one for the plant and one for operating the loading apparatus for boats.

The drag lines used at this plant are particularly interesting. Previously, a steam drag line, carrying a 3 cubic yard bucket, was used, but it was found that an electric drag line carrying a 1½ cubic yard bucket could do as much work in the same time, owing to greater speed and steadier operation. There are two of these drag lines now in operation at this plant. These drag lines are operated by 250 volt, d.c. motors supplied by means of a 50 kw. motor generator set. The motor used for raising the bucket is rated at 75 h.p. and the one used to pivot the machine is rated at 30 h.p. These machines pull 100 per cent. overload for a period of five seconds during the loading of the bucket and are operated at more than three thousand feet from the sub-station, power being transmitted to them over a line consisting of 250,000 and 500,000 circular mil cable.

The material is transported from the pits to the plant by means of steam locomotives and dump cars, and is dumped into two large hoppers. It is conveyed to the centre of the hoppers by means of small rubber belts driven by two 5 h.p. motors. From here it is conveyed up a steep

CONTENTS

Vol. XVI No. 10

October, 1929

	Page
Large Gravel Plant Operating Hydro-Electric Power	337
The Use of Graphic Meters in Industry	341
The Short Circuit Calculating Table and its Applications	349
The Klydonograph as a Lightning Recorder	359
Oxygen and Hydrogen in Industry.	364
National Safety Congress	371
Hydro News Items	374

incline to the plant hopper, at a height of approximately 75 feet, by means of a large belt conveyor driven by a 50 h.p. motor. It is transferred from here to the screen by means of a short belt driven by a 5 h.p. motor. The screen is driven by a 75 h.p. motor, which also drives another similar screen when the plant is operating at full capacity. The material is forced through the screens by hydraulic pressure, the water being forced up a six inch pipe by means of a rotary pump driven by a 50 h.p. motor.

The material is then washed, screened and graded and comes to rest in large bins, and from here it is transferred to the storage pile by a series of two belts driven by 50 and 100 h.p. motors respectively. The method of dumping the material on the storage pile at any desired point, depending on grade of material, is interesting. The belt is looped into an S shape by means of rollers in a moveable hopper. Thus the material is on the belt at the top of the S, but falls into the hopper when the belt turns downward and is diverted to the storage pile through the hopper. This mechanism may be moved to any desired point above the storage pile on tracks placed there for the purpose.

Underneath the storage pile is a concrete tunnel, in the roof of which,

Electric Drag Line Shovel in gravel pit. This electric shovel does the same amount of work using a 1½ yard bucket as was formerly done by a steam drag line using a 3 yard bucket.

General View of Screening and Washing Plant.

at regular intervals, are gates which may be opened to allow the material to flow through on to a conveyor belt some 300 ft. in length and 30 inches in width. In order to load a boat the gate under the desired grade of material is opened and the material drops onto the moving belt, and is conveyed to the boat (about half a mile away) by a series of belts driven by motors varying in power from 50 h.p. to 100 h.p. The final belt which drops the material into the boats is on a moveable shuttle, driven by a 10 h.p. motor, and may be moved considerably to reach any particular boat.

The wharf itself is about 1100 feet long and the main pump, which supplies the water for washing the material, etc., is located about half way out on the wharf and has a

Cylindrical Screens and Storage Pile.

Belt Conveyor from Storage Pile to dock. Relaying gravel from one belt to another.

capacity of 1900 gallons per minute, and is driven by a 100 h.p. motor.

This plant can produce the material and load the boats at the rate of from 1000 to 1200 tons per hour.

Thus it may be seen that hydro-electric power plays a very important part in the operation of this plant, as it also does in most modern plants and factories in Ontario where a great deal of the work is done by machinery.

Loading Dock.

The Use of Graphic Meters in Industry

By A. R. Wells, Meter Engineer, Operating Dept., H.E.P.C. of Ontario.

(Presented at Toronto Section, A.I.E.E. October 11, 1929.)

THE purpose of this paper is to describe some of the uses to which Graphic Meters have been put, and to describe Meters in such a way that a clearer idea may be had of the best type of meter to use for a particular purpose. A complete example will be worked out showing the calculations for one assumed example.

Different Uses of Meters

Graphic Meters may be used to very good advantage in making a record of the quantity of production. Fig. 1 shows the record of the load taken by a manufacturing plant, and shows that the productive effort of the factory is 11.8 per cent. less than that possible if the employees started work immediately and did not stop work until quitting time.

Other information which is to be obtained from this chart is as follows:

(*a*) Day load is 1,350 kilowatts, assuming that the scale markings of the paper are correct. It is not at all wise to assume that the correct paper has been used because many errors occur due to this assumption. It is always necessary to collect complete information as to the ratio of the instrument transformers, and also to get the complete name plate data of the instrument being used before it is decided whether or not the correct paper markings are being used.

(*b*) The night load is 180 kilowatts. This seems low if the power is being purchased on any contract in which peak load determines the price of the power purchased.

Fig. 2 shows a factory in which the employees start work sharp on time and work until the whistle blows. This chart has been given the title, "conscientious or closely watched." Possibly the real solution is the fact of the use of the piece work rate in the factory.

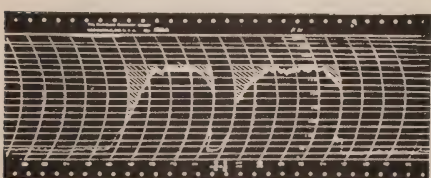


Fig. 1.—Graphic record of the power consumed by a department of a manufacturing plant. The shaded areas show a loss of 11.8 per cent of the productive effort of the employees.

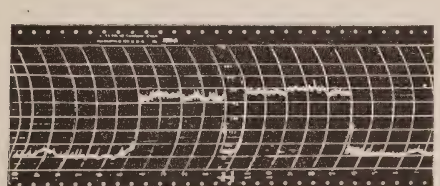


Fig. 2.—Record from a department of another plant, showing no loss of time. Employees begin work promptly and do not anticipate quitting time.

As in the case of the previous chart the value of the peak load is shown as 300 kilowatts, and the night load as 75 kilowatts. From the character of the chart it would seem that a portion of this factory operated at night, thus increasing the load factor of the power taken and in that way decreasing the power cost per unit of production, provided that the power is being purchased partly on a peak basis.

The fact that a factory starts up very quickly may have a decided effect on the power bill because many types of machinery starting take much more load than when thoroughly warmed up. A good example of this is a flour mill where the load at starting and during the first half hour is probably 15 per cent. greater than after the mill has been running for some time. If other machinery is started up at the same time, the peak load will be increased by that amount.

The Quality of the Product

Fig. 3 and 4 show a record of the operation of a cement mixer when using, first, a standard paper speed or 3 inches per hour, and second, the record of one operation of the same cement mixer when using a much higher paper speed of 8 inches per minute. These charts were given me by Mr. Young of the H.E.P.C. laboratories, and it was with some difficulty that I obtained a chart showing anything but a perfect record. He stated that it had been found that the workmen do not like to see a poor looking chart. A number of notes were made on the chart regarding the cause of the

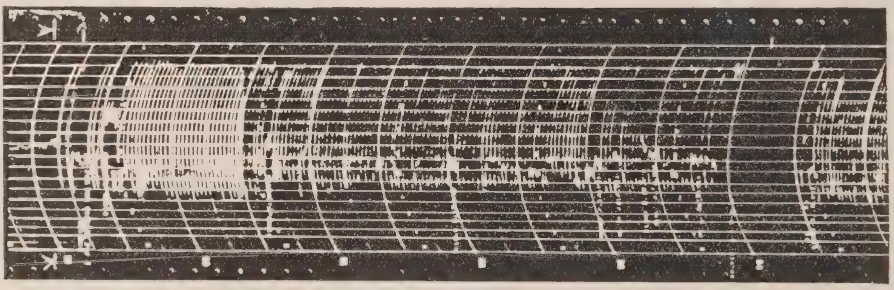


Fig. 3.—Record of a Cement Mixer with a paper speed of 3 in. per hour.

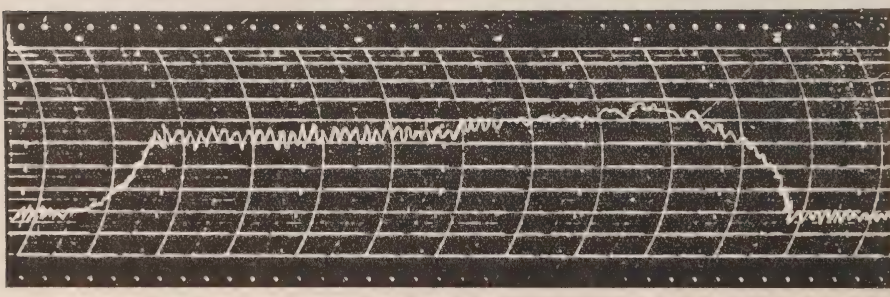


Fig. 4.—Record of a Cement Mixer with a paper speed of 8 in. per minute.

various delays shown. The one which appealed most to the writer was "Pen not inking". The different inks used in Graphic Meters all have unpleasant tastes and until recently the only way to get the ink started flowing was to suck it through the pen. One manufacturer now has a device to start the ink flowing through the pen without leaving an unpleasant taste in one's mouth.

When describing the chart at high speed, Mr. Young described the processes of mixing cement from the value of the load taken and the characteristics of the chart. From his description one could almost see the concrete sliding off one blade of the cement mixer and on the next. A person who is familiar with the particular process is always able to corrobate his ideas as to the sequence of events in any particular process from the load as shown on a high speed chart. By some study, however, he is able to obtain new information which may be of great value. From the value of load the H.E.P.C. engineers were able to check up on the following points :

(*a*) Consistency :
  Too much water or too much sand.
(*b*) Size of batch.
  When grout is used.
(*c*) Number of batches mixed.
(*d*) Duration of delays :
  Motor repairs, changing chute, waiting for material.

Power Bills

By having the proper graphic meter connected to the cord the total plant load the amount of the power bill received from the Power Company may be checked up. This is a very desirable thing because, although it is annoying to the power company to have their bills questioned, yet the purchaser of power has much greater assurance that his power bills are correct. It must be remembered, however, that the gentlemen of the accounting department are accustomed to dealing with amounts to the last figure, even though the last figure may represent a very small fraction of 1 per cent. of the total amount. Because of this many incongruous items appear in power bills, for instance, graphic or other meters can only record the amount of power taken to say, within 2 per cent. of the true amount. By the time the bill passes the accounting department the bill may appear as $1,287.85 which is quite ridiculous because the meter can only measure the power to within $20.00 on this amount. It would be obviously ridiculous to quibble about $10.00 in the amount of the above power bill, because the accuracy of the original information obtained from the meters can only be taken as being within 2 per cent. of the correct amount.

Timing of Events

Fig. 5 shows the record obtained from a timing Recorder, as used to record the time and duration of telephone calls. The number of devices whose operation can be recorded on an instrument of this type is limited by the number of pens used, but one manufacturer supplies a meter with twenty pens. To a person familiar with the operation and maintenance of Graphic Meters, the question naturally arises how many

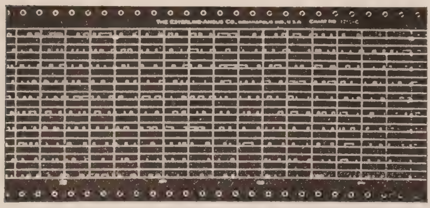


Fig. 5.—A record showing the number of calls and the duration of each call on ten telephone lines.

of these pens can be made to ink at once, as this is the great difficulty with Graphic Meters. The variety of information that can be obtained from a chart record is quite great, hospital calls, frequency of street cars, operation of valves and oil breakers in power plants, direction of wind, operation of automatic substations, street lights, automatic machines of all varieties, blast furnaces and speeds of trains.

Special Work

Fig. 6 shows a very familiar graph from a mechanical type of Graphic Meter, which is given because it shows what information can be obtained by the careful use of the record of a Graphic Meter. The students of Thermo Dynamics can well remember the hours spent in the study of one poor little indicator diagram. There is no real reason why the information obtained from the record of Graphic Meters should be any less complete or varied than that obtained from an indicator diagram. In all of the records from Graphic Meters shown accompanying this paper, the rate of paper travel is dependent on time, but special meters could be made in which the rate of paper travel could be made proportional to any desired quantity, and the movement of the pen across the paper could be made proportional to any other desired quantity.

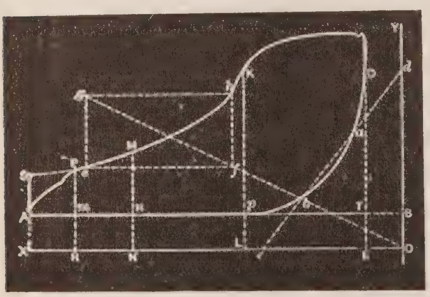


Fig. 6.—A steam engine pressure diagram made by a mechanical type of graphic meter.

Equipment Available

Fig. 7 shows the most complicated use of Graphic Meters known to the writer. It shows a combination of three duplex Graphic Meters driven by a single driving motor so that all of the charts coincide exactly. The meters are so connected to current and potential transformer having

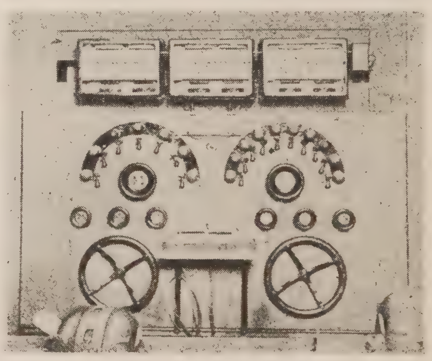


Fig. 7.—Three duplex graphic meters driven by a single driving motor so that all of the charts coincide exactly.

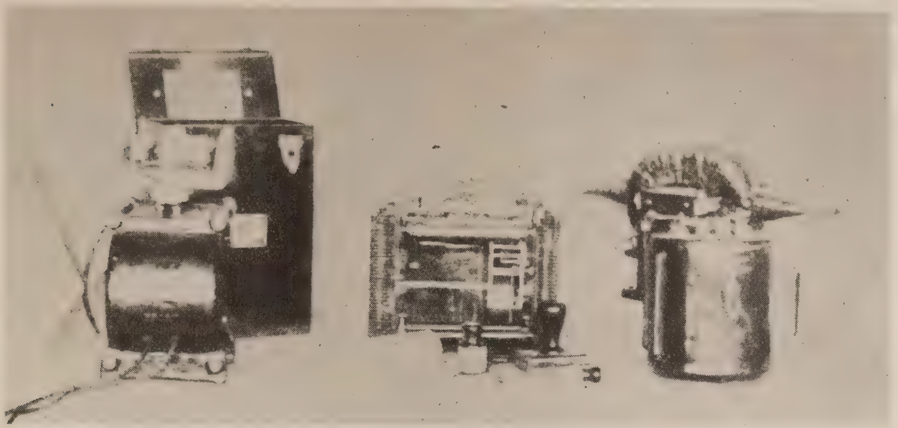


Fig. 8.—A small, old type graphic wattmeter and auxiliary equipment required for its operation.

many different ratios, that it was made possible to record the characteristics of the many varied sizes of electric motors which pass through a manufacturing establishment which has introduced the use of the moving platform. The lamps shown in the form of a semi-circle above the two upper operating handles indicate to the operator what the potential and current transformer ratio is and this is marked on each of the charts, on which is also marked the name plate data of the motor being tested. In this way a complete record is made of the motor characteristics in a very much shorter time than is usually possible. If the writer ever has the opportunity he intends to visit this plant to see the operation of these meters and the type of records obtained.

Meters Measuring Electrical Quantities

Fig. 8 shows a small graphic Watt Meter of an old type and the auxiliary equipment required for its operation. The Graphic Meter is shown in the centre, and in front of it are shown some of the minor pieces of equipment necessary, but the lack of any one of which is liable to make it impossible to obtain a record or destroy the value of the record at a later date. There is a roll of paper and it is quite necessary, of course, that there be a sufficient supply of paper with the meter at all times. A bottle of ink is shown, and in the later meters space is provided in the case of the portable meters so that the ink supply need never be removed from the meter. A pen filler is also necessary, and also a device for starting the ink flowing in the meter pen. A rubber stamp is shown which is not often included with the meter supplies, but the writer considers it essential so that a stamp may be made on every chart which has been so designed that the operator is reminded of all of the information required to make the chart of value. The essentials are as follows: date, meter location,

load being measured, current transformer ratio, potential transformer ratio, meter full scale, paper speed, if this is other than that shown on the paper.

The current transformers are shown on the right. The one in the foreground is a multiple range current transformer having four ratios. The one at the back is an ordinary station type of current transformer with a single ratio. No current transformer of the clamp-on type has been shown because it is not considered advisable to use one of that type on account of its large ratio and phase angle errors. The station type of current transformer has been shown because there are frequently current transformers of suitable ratio available in any particular plant and the aggressive electrician will soon dig up sufficient equipment to make more or less complete tests even though the executives cannot see sufficiently far ahead to authorize the expenditure of sufficient money to purchase a complete new set of testing equipment.

Potential transformers have been shown to the left of the meter and both the portable and station type have been shown because there are many cases where it is not necessary to use portable type transformers at all. It is frequently possible to put the meter into service supplied from the existing metering equipments on the feeders to the various departments of the factory.

Typical Graphic Meters

Fig. 9 shows the view of a direct acting type of the latest model manufactured by a large electrical manufacturer. The view given is

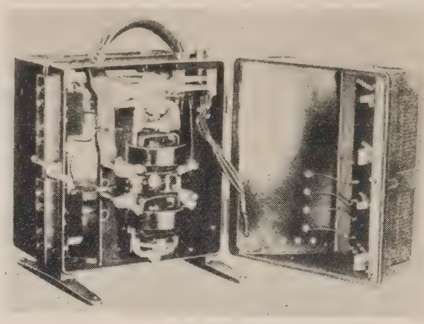


Fig. 9.—Direct acting type of graphic meter, back view showing measuring element.

that with the back of the meter swung open to allow a view of the measuring element. The other two major portions of the meter, that is the paper holding mechanism and the inking mechanism are not clearly visible in this but the details can be seen from later illustrations. This particular meter is a power phase watt meter of the iron cord dynamometer type.

This illustrates a direct acting meter and has several novel features. The pen is one of the long variety and the ink well is mounted on the upper end of the shaft of the moving element. This gives the desirable feature that the back end of the pen does not have to move in the ink well, and since there is a small cup in the bottom of the ink well, the ink can be used to the last drop. It has been found that if the ink well is completely full the supply of ink will last a month when the meter is recording at approximately the same point all the time as is the case when recording voltage. The manufacturers have not gone quite far enough toward making the pen and ink reservoir

easily removable. However, the meter is a great advance over their previous product.

The terminal block can be seen at the left hand side of the meter, and seems to be a very good one. On the door will be seen a number of contacts which are placed there so that as soon as the back of the meter is opened the potential circuits of the meter are killed. This is a very desirable feature because it is very easy to get a short circuit which will do considerable damage to a meter.

This meter has been so designed that the meter can be made so that it will not overshoot and the pen speed is such that the pen will move from full scale to zero in approximately one second. The damping is electromagnetic and is easily adjustable. Experience has shown that it is necessary to clean out the ink well and pen with hot water at least every month if a continuous record is to be obtained.

This meter can be equipped either with a hand wound clock or a small synchronous motor. Both types of drives have their advantages, the principal advantage of the synchronous motor is that it will keep on running without winding and that if a number of meters are driven from the same potential supply the charts will all be in synchronism. Of course if the power fails, the meter will stop and not only will the timing be incorrect, but the record of power failure and its duration will be lost.

Fig. 10 shows the most recent model of the relay type of graphic meter, this particular one being a polyphase watt meter. The measuring element of this meter is a Kelvin balance and has the unique feature that the electrical force is opposed by a moving weight. Mr. H. S. Baker of the H.E.P.C. contends that since a merchant is not allowed to sell commodities on the basis of a spring scale in excess of 15 pounds, that it is ridiculous to sell electricity to the amounts of many thousands of dollars on the record of a meter in which the electrical forces are opposed by a spring. For this reason he has developed the gravity type of control as used first in the large multi-element Graphic Meters built by him, and later this particular manufacturer has been able to see fit to adopt this principle in their meters. There is, of course, the fly in the ointment that the portable standard meters used to caliberate these graphic meters are spring controlled. However, this type of graphic meter could be caliberated on direct current using a

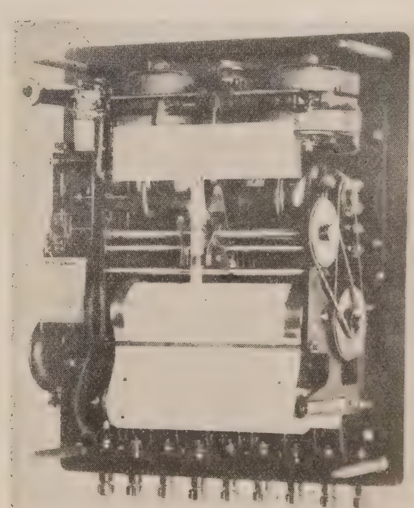


Fig. 10.—Most recent model of the relay type, polyphase, graphic watt meter.

potentiometer, thus avoiding the use of any spring controlled meter. This shows very well the essential parts of any Graphic Meter.

The first considered is a paper holding and driving mechanism. The new roll of paper is shown at the back of the meter and the paper is carried up and over the driving roll which is equipped with pins to engage the perforations of the paper. The paper is kept in place by paper guides at the ends of the paper drum. These pins must be absolutely the same on all meters so that paper can be accurately punched because this point of poorly punched paper gives a great deal of trouble when the paper gets off the pegs and jams in the meter. What is called the re-roll is shown at the front of the meter and the success of this device determines to a great extent the frequency with which the Graphic Meters must be attended to. This particular meter has its re-roll driven forward each time the electric motor which winds the clock operates. The difficulty with this type is that the pull of the belt is liable to pull too hard on the paper and either pull it off the pegs or loosen the paper drum, but it gets away from the trouble experienced on re-rolls which are driven from the paper drum, because in that case the more paper there is on the re-roll the faster it will roll up, because the roll is being driven at a constant speed.

The clock which drives the paper roll is shown on the left, and is a self-winding pendulum clock, which has been found to be very reliable. The motor of this clock winds each hour and if the meter is to be visited by a meter inspector only every six months the motor must wind over four thousand times between visits if the record is to be continuous.

This meter is of relay type and, of course, requires a source of potential to operate the control motor which is shown just below the measuring element. The contacts which control the motor are shown at the upper left hand corner of the meter. Since these contacts must start and interrupt a current many times an hour, they must be made of a very good material, and anything which can be done to reduce sparking at these contacts is essential, because otherwise the contacts will pit and the meter will become insensitive to small changes in load. This meter has not been used to any great extent for portable use because of the pendulum type of clock, which must be accurately levelled for good operation.

The pen on any Graphic Meter is a very important part. The pen on this type of meter has been found to be quite reliable and will hold sufficient ink to last for a month's operation on loads having ordinary fluctuation. The point of the pen consists of a platinum iridium tube, having a very small bore. The pen can be removed from the meter for refilling and the penholder is such that the meter will go back to exactly the same position.

Continued in November number.

The Short Circuit Calculating Table and its Applications.

By M. P. Osburn, Electrical Engineering Dept., H.E.P.C. of Ont.

THE short circuit calculating table is a device for readily calculating short circuit currents and analyzing alternating current networks.

The necessity for such a device has arisen with the advent of the modern power system with its extensive interconnections. Analytical solutions of these systems are laborious and in many cases, practically impossible.

The short circuit calculating table is used for the solution of two distinct classes of problems, namely, those involving the design and those involving the operation of large systems. Problems of the former class are enumerated as follows :

(1) The calculation of the magnitude and distribution of fault currents in a proposed system of interconnections, especially where single phase line-to-line and line-to-ground faults are being considered. This information is necessary in the design of relaying systems, for the comparison of various schemes and for determining relay settings. It is also necessary in problems involving the prevention of inductive interference between power and communication circuits.

(2) The selection of oil circuit breaker ratings.

(3) Studies as to the necessity of current limiting reactors and the selection of their rating.

(3) The design of bus supports and bus structure to withstand magnetic stresses.

(5) Studies of stability of a proposed system and maximum power which can be transmitted.

(6) Studies of various proposed line arrangements as the system develops.

Problems relative to the operation of large power systems mainly involve the analysis of fault phenomena occurring on the system, the solution of which furnish important information regarding

(1) The operation of the relay system ;

(2) The behaviour of oil circuit breakers ;

(3) The nature of faults.

The Commission has recently purchased a short circuit calculating table of the variable resistor unit, direct current type. Although it is designed primarily for the solution of networks wherein the reactance values can be represented by resistance values, it is with some precaution applicable to net works where the values of resistances are appreciable and where dissimilar impedance angles are encountered in the various elements of the network. In general, the system to be studied is "set up" in miniature form by connecting together a number of resistors whose values are proportional to the reactance values of the actual system. A

Fig. 1.—General front view of Short Circuit Calculating Table.

known direct current voltage is impressed between a positive bus to which all resistors representing generators are connected and some point of desired fault. A reading of milliamperes for total current as well as for branch current will give values proportional to the actual instantaneous symmetrical short circuit current for that particular point of fault.

Fig. 1 shows a front view of the short circuit calculating table used by the Engineering Department of the Commission. It is manufactured by the Westinghouse as a standard piece of equipment in units containing 48 resistor circuits each. The centre or main unit contains the motor generator set and meters. To this main unit has been added a left hand unit as shown in Fig. 1, providing a total of 96 resistor circuits. If, in the future, this number of circuits is found to be inadequate, a right hand element,

similar to the left may be added, thus providing a total number of 144 resistor circuits.

The resistors are mounted on the upright section of the table, 12 to a panel. Two standard telephone cords are used as leads for each resistor and terminate in plugs which are located on the horizontal section of the table. A view of the front sections of the table with the tops raised is shown in Fig. 2. One cord is coloured red, the other black, to simplify the tracing of circuits in a step-up. Directly beneath the rheostat panels are located eight sections of telephone jacks, each section being composed of seven rows of ten jacks each. These jacks are connected together in such a way that plugs in adjacent jacks are connected together, but an empty jack isolates

Fig. 2.—View of front sections of table with the tops raised.

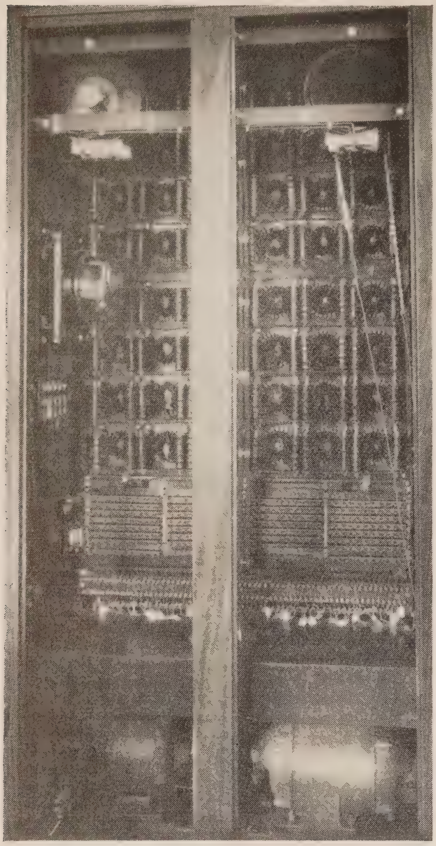


Fig. 3.—View showing the back of the centre unit of the Calculating Table with the doors removed.

plugs in the same row; see Fig. 4. Relay circuits are provided so that when a plug is inserted in the first or last jack of any group, connection is made through cross wiring to the first or last jack of the alternate remaining groups. This practically eliminates the necessity for crossing cords between panels when making a set-up. These jacks provide a means of tying together the resistor circuits in such a manner as to represent any possible system of interconnections. The jacks in the bottom row of the end panels of each unit are all connected together and form the positive bus to which the positive end of the d.c. generator is connected. The negative side of the generator is brought out by two telephone cords, terminating in plugs, so arranged as to allow insertion in any jack adjacent to any point in the system interconnection. This provides a convenient means of placing a short circuit at that point in the network. A voltmeter having a range of 0-60 volts and a milliammeter with zero centre scale, having 3 ranges, 0-25, 0-100, 0-500 milliamperes, are located on the horizontal section of the main unit. A telephone key in each resistor circuit allows the circuit to be connected to a common ammeter bus allowing readings of branch circuits to be made. A totalizing key is also provided in each of the two negative cord circuits. The motor generator set consisting of a 400 watt, 40 volt d.c. generator coupled to a ¾ h.p., single phase, 25 cycle, induction motor, is located in the rear of the bottom section of the main unit; see Fig. 3. The d.c. voltage is controlled by a rheostat in the field of the generator or by a vibrating type regulator where the a.c. supply for the motor is not stable. A typical circuit diagram of the connections for the calculating table is shown in Fig. 4.

Each resistor is adjustable over a range of from 80 ohms fixed to 4,480 ohms maximum resistance. The lower arm of the resistor increases the resistance in steps of one per cent, from 2 to 12 per cent., and the upper arm in steps of 10 per cent., from 0 to 100 per cent. Hence the relation between

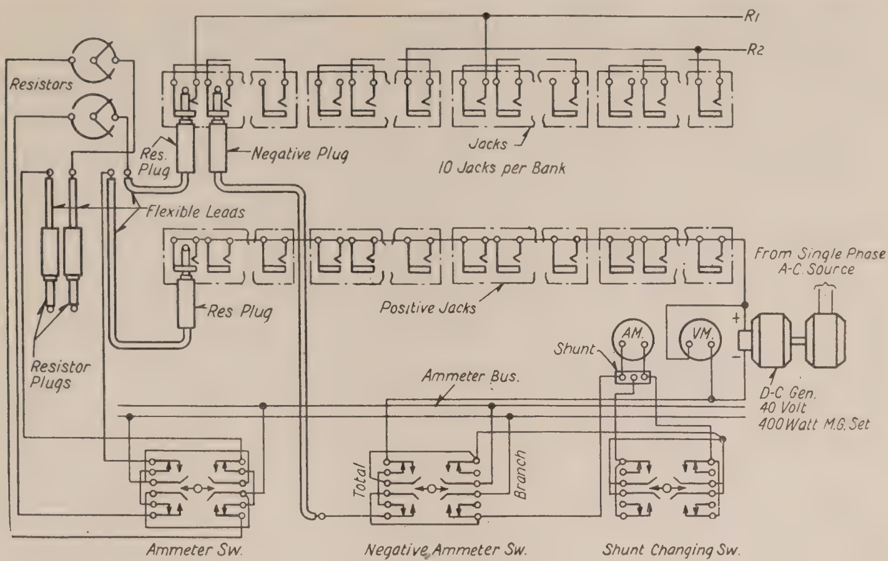


Fig. 4.—Typical Circuit diagram of Calculating Table.

the dial setting and the actual resistance in ohms is 1 to 40. Since 40 volts is used on the calculating table, a fixed resistance of 80 ohms which represents a reactance of 2 per cent., is included in each resistor circuit, to limit the maximum current to 0.5 amperes.

To determine the dial setting, the value of the reactance to be set up, is expressed in per cent. on a chosen kv-a. base, and a suitable multiplier used to adapt the range of reactance values to the dial settings. Thus, with a multiplier of one, a dial setting of 100 per cent. means 100 per cent. reactance on the given kv-a. base, or represents a short circuit current equal to the full load current at the given kv-a. base and operating voltage at the point of short circuit. Since a dial setting of 100 per cent. represents 4,000 ohms, with 40 volts impressed on the calculating table, the current flowing would equal 40/4000 or .01 of an ampere. Hence the instantaneous symmetrical short circuit current "I" may be expressed as follows :

$$I = (i \times A \times K)\ 1/.01$$
$$= 100 \times i \times A \times K.$$

where i = direct current amperes as read on the calculating table ammeter.

A = full load current at base kv-a. and operating voltage at the point of short circuit.

K = multiplier used to adapt the range of reactance values to the dial settings.

In setting up a system for study on the calculating table, a single line diagram of the system is first drawn, showing the reactance of all generators, synchronous machines, transformers, reactors, and lines, in per cent. on a convenient kv-a. base. In order to facilitate locating each station or piece of equipment on the system, a set-up chart is prepared which gives a physical representation of the plugs

and jacks as actually arranged on the calculating table. The complete system is then set up on the chart, and the name or designation of each station recorded, together with the number of each resistor used and its

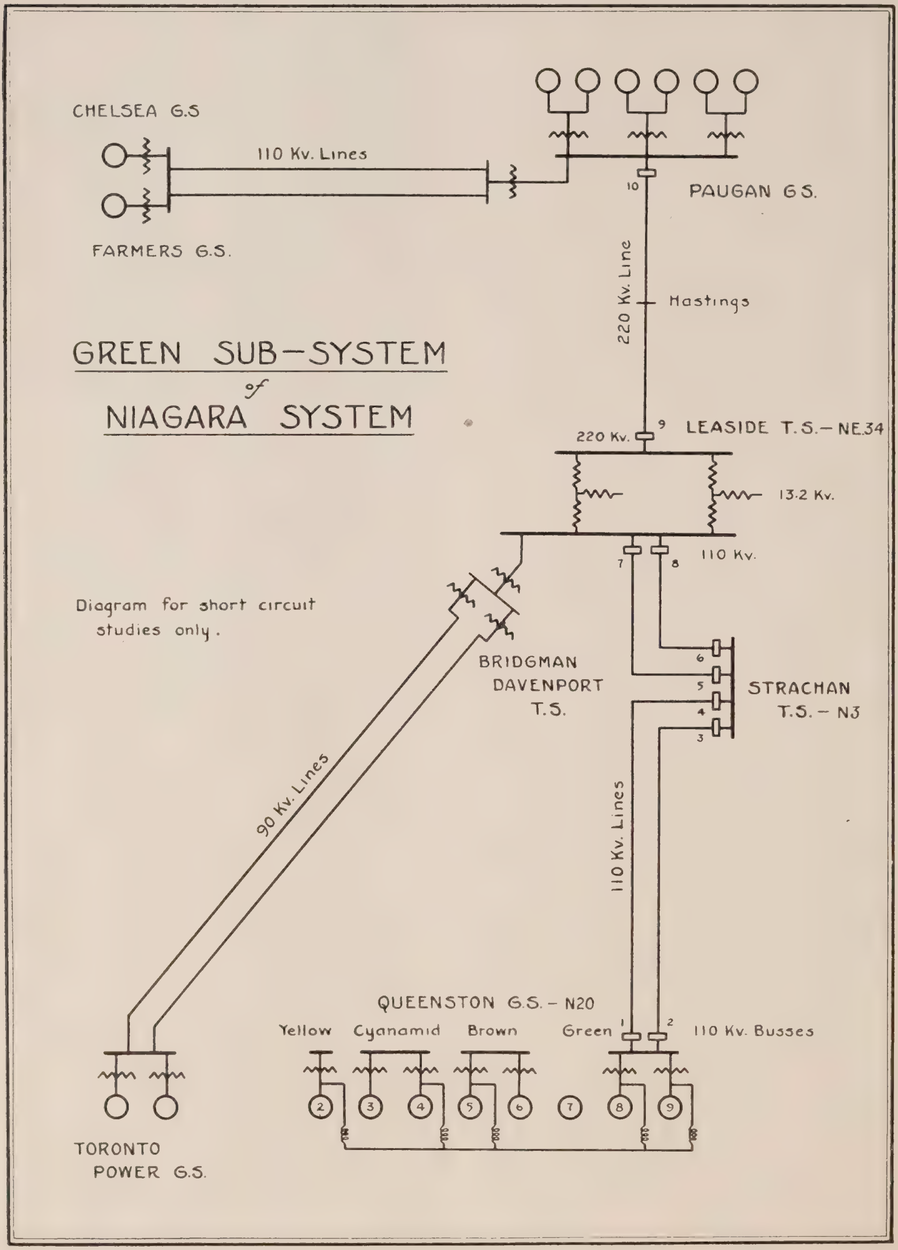


Fig. 5.—Diagram showing "Green" sub-system of Niagara System.

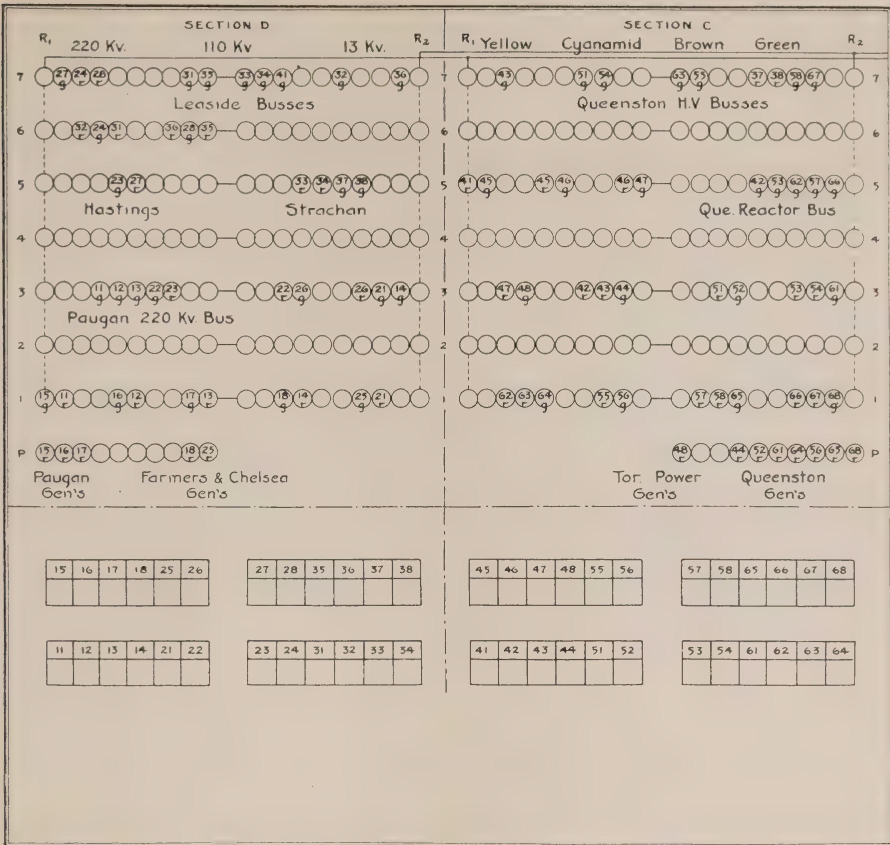


Fig. 6.—Set-up chart. Reactance values are entered in blank spaces below resistor numbers.

dial setting. From this chart, the system is then set up on the calculating table.

A typical problem illustrating the use of the short circuit calculating table will now be considered. The problem requires the calculation of the 3 phase instantaneous symmetrical short circuit current and the oil circuit breaker duties at the various stations on a "Green" sub system study of the Niagara System, as represented by Fig. 5. It should be noted that this diagram is not in accordance with the actual system layout, but embodies the essential connections for an example. The values of reactance used are expressed in per cent. on a 10,000 kv-a. base. To adapt these values to the dial settings, a multiplier $k = 10$ is used. The set-up chart shown in Fig. 6 is then prepared. For ready reference, a tabulation is made up, giving the resistor number and dial setting for each piece of equipment on the system. For simplicity, only the left hand unit of the calculating table is used for this problem.

Referring to the set-up chart, the

red plug of resistor No. 68, representing No. 9 generator at Queenston, is connected to the positive bus, the green plug of the same resistor is inserted in row one, right hand side. Adjacent to this green plug (therefore making a solid connection) is inserted the red plug of resistor No. 67, representing No. 9 transformer at Queenston. This connects resistor No. 67 in series with No. 68. The green plug of 67 is inserted in row 7, and this point marked Queenston H.V. Bus-Green. The red plug of resistor No. 66, representing No. 9 reactor at Queenston, is inserted adjacent to 67 in row one and the green plug of 66 is inserted in row 5, and this point marked, Queenston reactor bus. In a similar manner, the remainder of the resistors are connected together to represent the entire system as shown in Fig. 5. After checking the layout on this chart, the actual set-up is made on the calculating table, the location of the plugs and the dial settings being in exact accordance with the chart. A detailed view of the cord connections and dial settings is shown in Fig. 7.

The value of short circuits and oil circuit breaker duties are more conveniently expressed in kv-a. than in terms of amperes. With the reactances expressed in per cent. on a 10,000 kv-a. base, 100 per cent. reactance represents a short circuit of 10,000 kv-a., and a reactance of 10 per cent. represents a short circuit of 10 times the base or 100,000 kv-a. Referring to the formula above expressing the value of the actual short circuit current in amperes, it is seen that in multiplying this formula by the Kv x $\sqrt{3}$ to express it in terms of kv-a., we obtain the same digits as expressed by the milliammeter reading "i." Hence, the milliammeter reading with a multiplier of 10,000 expresses the value of the short circuit directly in terms of kv-a. Thus, a dial setting of 20 per cent. representing an actual reactance of 2 per cent. would give a reading of 50 milliamperes, which on multiplying by 10,000 would indicate a short circuit of 500,000 kv-a.

Readings of the total short circuit kv-a. and of the kv-a. supplied to the fault from each of the four generating stations, are recorded in the table shown in Fig. 8 for the various locations of the fault.

The oil circuit breaker duty shown in this table for each breaker indicated on the system, is the kv-a. which the breaker must interrupt under the most severe fault condition. For example, the maximum duty imposed on No. 1 breaker, will be obtained when the line on which the breaker is located is open at the other end.

The generator reactances used in the above problem are transient values and are used to obtain the instantaneous value of short circuit current. Where sustained values of short circuit current are required, decrement factors must be applied to the short circuit current delivered to the fault by each generator on the system. For a given value of transient reactance based on generator rating, these factors show the amount by which the normal generator current must be multiplied to express the value of the short circuit current delivered by the generator after

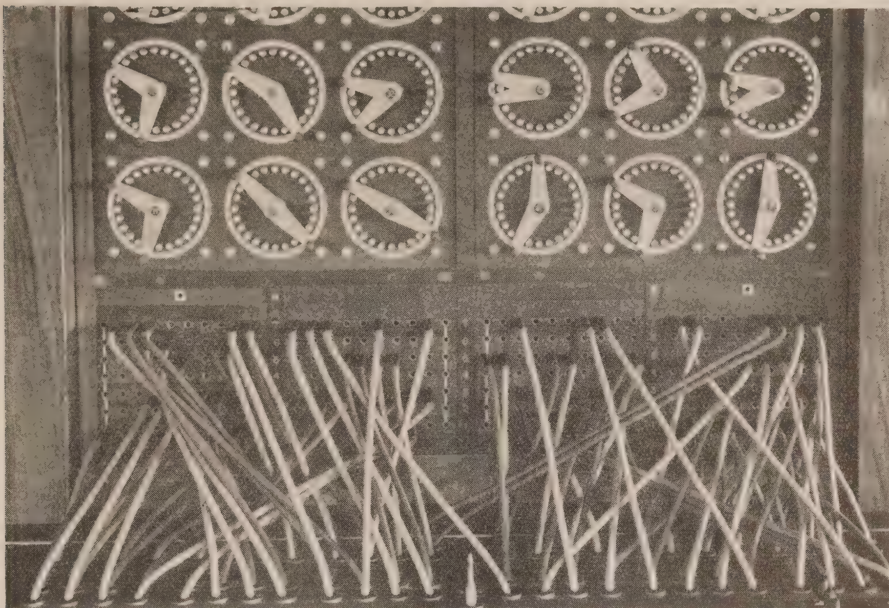


Fig. 7.—Detailed view of actual set-up on Calculating Table.

TABLE SHOWING CALCULATION RESULTS

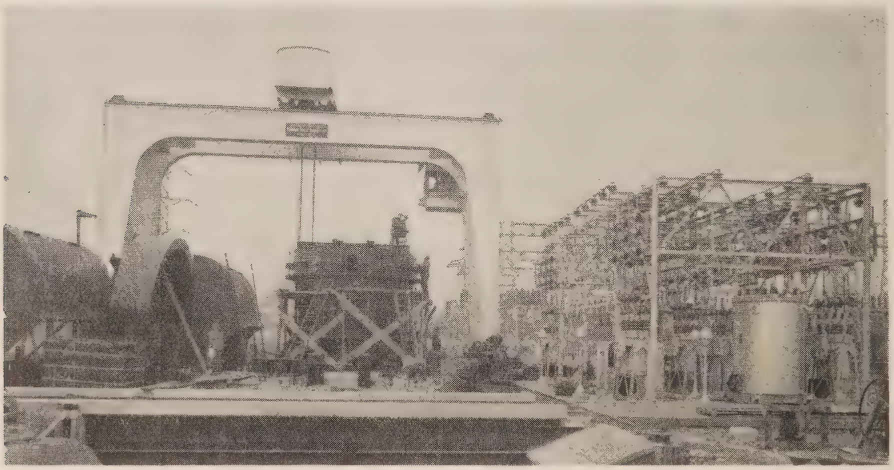
Location of Fault	Short Circuit—mv-a. From FC	Paugan	N20	T.P.	Total	Max. O.B. Duty O.B. No.	Duty mv-a.
Queenston H.V. Bus. Green..............	35	135	540	60	770	1 2	710 710
Strachan—N3....... H.V. Bus...........	45	174	348	78	645	3, 4 5, 6	550 630
Leaside 110 kv. Bus	48	182	330	80	640	7 8	625 625
Leaside 13.2 kv. Bus	32	120	148	35	335		
Leaside 220 kv. Bus	70	265	210	55	600	9	335

Fig. 8

a given interval of time has elapsed from the instant of short circuit.

Problems requiring the calculation of single phase line-to-line short circuit currents require the solution of first a positive phase sequence network, identical with the three phase and second, a negative phase sequence network similar to the positive with the exception that all resistors representing generators are given a setting equal to 73 per cent. of their former three phase value. Single phase line-to-ground calculations require the above two solutions in addition to the solution of a zero phase sequence network, which involves only those branches of the system which have an actual connection with ground.

The Short Circuit Calculating Table is available for use by the Commission's Engineers in calculating circuit breaker duties or other similar problems for any of the Hydro Municipalities.



View during installation of 25000 kva. outdoor synchronous condenser at Toronto Leaside Transformer Station, showing 80 ton gantry crane and 13kv. switching installation with starting auto-transformer for the condensers.

The Klydonograph as a Lightning Recorder

By W. B. Buchanan, Assistant Laboratory Engineer, H.E.P.C. of Ont.

THE adequate protection of electrical transmission lines and substation apparatus is a problem that has forced itself on the attention of all engineers interested in electrical power transmission from the commencement of the construction of overhead lines. In the early stages of development, cut and try methods were the rule, and remarkably good equipment was developed considering the difficulties of the problem. Thunderstorms and lightning discharges cannot be produced on request, and this hampered developments. No apparatus was available for measuring the quantity of energy that was released during a lightning discharge and any estimates made involved very indirect methods of arriving at any conclusion. Hence, any quantitative data was very scarce and of such doubtful value as to be of little benefit unless supported by field experience with apparatus.

Recently, however, two large manufacturing companies have undertaken studies of lightning and its behaviour on a fairly large scale. Their purpose doubtless was to determine the stresses to apparatus which they are now building and that which they expect to build in the future will be subject. Lightning generators have been built and used in conjunction with standard transmission lines. Measuring devices have been devised and kept in continuous operation to record such discharges as may arrive naturally and automatic cameras have been developed and used to photograph flashes that may appear. The net result is that we are told that lightning discharges may give rise to voltages on a transmission line as high as three million volts, more than twenty times the highest normal line to ground operating voltage ; that starting from nothing a stroke will reach its maximum value in one-millionth part of a second and while reducing more slowly it will be practically gone in fifty-millionths part of a second. But where ? It becomes the problem of the designing engineers of transmission lines and substations to take this dynamic surge of lightning, provide it with a specially prepared path, and lead it safely to where it can do no harm.

Obviously, the expenses of investigations of this nature are so high as to be practically prohibitive for the most of purchasers and users of equipment, and they appreciate the services being rendered by the manufacturers along these and similar lines. Adequate protection, however, involves a study of the local aspects of the problem, such as climatic conditions, elevations, ground conditions, and in general the exposure of equipment to lightning storms.

The engineers of the Commission engaged in this problem felt that as much local information should be obtained as possible in connection with the 220,000 volt transmission of

power to Leaside, in order that lightning hazards might be reduced to a minimum and have in a comparatively modest way been conducting some field tests as well as studying the subject theoretically.

About seven years ago a special investigation was referred to the Laboratories which required a knowledge of the maximum potentials which would be produced on various parts of a line during some special cases of trouble, these being of very short duration. The only practical method of obtaining any measure of these voltages was to make use of a phenomena which had been known for over a hundred years, but which had not been applied to transmission engineering until brought to the attention of electrical engineers by members of the staff of the Westinghouse Electric and Manufacturing Company. This was to the effect that a sensitized emulsion on a photographic plate would be affected by the application of high voltages, *e.g.* 2,500 volts, and higher, and when developed in the ordinary way would show figures characteristic of the magnitude and frequency of the applied voltages. This reaction occurs below the range of visible corona or static streamers.

As no instruments were available at that time, members of the Laboratory staff of the Commission assembled an ordinary plate holder in a suitable box and after a sufficient number of tests in the Laboratory to check its dependability, tried out this new instrument in field tests. The results were quite satisfactory as far as the instrument itself was concerned and its use has been gradually extended until approximately one hundred of these boxes have been assembled, about one-half of that number being in service practically all summer, the remainder being available for special testing. These instruments are generally known as klydonographs.

The principal difficulty has been in devising suitable methods of connection to obtain a facsimile of line voltage at all frequencies and under

Fig. 1.—Line Klydonograph Installation at Leaside Transformer Station.

Fig. 2a

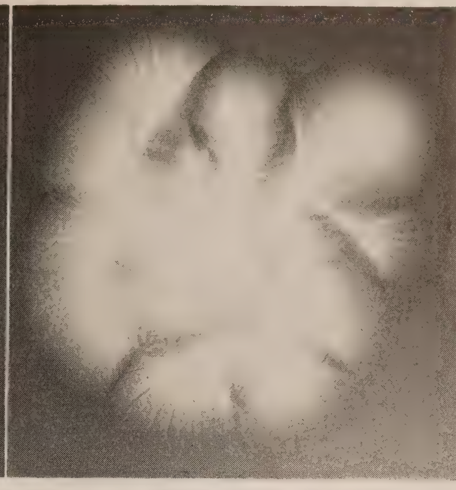


Fig. 2b

all conditions of weather and exposure. Also the tendency of the plate to become fogged due to elevated temperatures in locations where exposure to heat was unavoidable. The first objection is being overcome in the most of cases, and the latter can be avoided by frequent renewals of the plate. The information obtained by its use has been extremely valuable.

Two instruments designed on the same principle, but of a graphic type and using sensitized film, have been purchased and installed at the Leaside terminal station on the new 220,000 volt line to record the occurrence of lightning surges on the line and apparatus. The special advantage of this type is to segregate the various surges as to time of occurrence and these graphic klydonographs have already given good service. They are much more expensive to install and operate than the plate type mentioned, and such extensive use of the graphic type might not be warranted. Fig. 1 is a photograph of an installation which records surges on the three phases, also on the overhead ground wires.

During the period of building the first 220 kv. line to Leaside, a section of about fifty miles was available and a series of records were obtained over about twenty miles of this line, using klydonograph boxes connected directly to the power conductors. Some of the figures obtained are reproduced herein and tell their own story of high speed traffic and traffic laws. The larger image, Fig. 2b was obtained between line conductors and tower footings ; the smaller Fig. 2a represents a voltage drop due to current flowing into ground from the tower at that point.

Figs. 2b and 3a indicate a very high frequency of the nature of a direct hit, probably within 1,000 feet of the location of a cloud discharge to ground. This is confirmed by the tower potential at that point. As the lightning surge represented by

Fig. 3a travels along the line at a speed nearly equal to that of light it flattens in wave front like a wave of water on a lake, and gives rise to an image of a different type, Fig. 3b, one and one-tenth miles distant. The latter image can be used to obtain a fairly accurate estimate of the magnitude of the voltage occurring at that point, but the former indicates a magnitude and frequency beyond the capacity of any of our present apparatus to duplicate.

The purpose of this series of measurements was two-fold, *viz.* first, to determine the sequence of effects which result in a stroke of lightning causing an insulator string to flash over ; second, to determine how far surges normally travel on a line of this particular design and the per cent. reduction in maximum voltage per mile, the latter having an important bearing on the protection of terminal equipment. The results obtained have indicated that to avoid flashovers, the resistance locally, *i.e.*, of individual towers to ground, should be as low as can be made economically. The record shown as 2a was obtained on a plate connected between a tower footing and a point in the ground at right angles to the tower about thirty feet distant. By an approximate measurement about four ohms was included in this resistance drop, and about twelve thousand volts set up across it indicating a current flowing to ground at this point of approximately three thousand amperes, maximum value. The conclusion to be drawn from this result is that the individual tower grounds must be of low resistance if protection against outages from lightning is to be assured. Assuming a similar discharge through a ground resistance of four hundred ohms or higher, conditions would be set up which would favor a side flash from tower to line conductor and from which the line conductor would be otherwise protected. A somewhat limited amount of information is available on the second problem, and such records as have been obtained substantiate very

Fig. 3a.

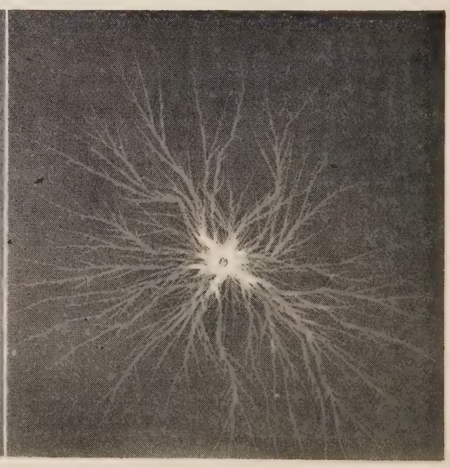


Fig. 3b.

well the generally accepted theory of lightning surges. It is expected that when certain improvements in connections have been perfected, more reliable quantitative data may be obtained.

The klydonograph has been and is likely to be subjected to a great deal of criticism as to accuracy and reliability. Some of these criticisms are justified, but others are introduced by idiosyncrasies of auxilliary equipment which should not discredit the primary instrument. In our opinion, however, it has already proven its value and is likely to remain a useful tool in the hands of investigators of high frequency, high voltage, electrical phenomena.

Hydro Insulators

"The 20 years which have followed the erection of the original Niagara Falls–Toronto line cover a period of remarkable development in transmission line construction all over the world; and the development of porcelain insulators to provide efficient insulation has kept pace with this construction.

"But it falls to the Hydro-Electric Power Commission of Ontario—the first to use cap and pin type, one piece, porcelain insulators to complete this twenty-year story.

"As this original line was an outstanding achievement of 1909, so is the new Gatineau line of the Hydro-Electric Power Commission equally outstanding in 1929.

"From Paugan Falls in Upper Quebec to the Leaside sub-station at Toronto, this 230 mile, 220 kv. line will bring 260,000 h.p. to the Hydro-Electric Power Commission system.

"This new line represents the most improved designs in tower construction; the latest and most advanced thinking in high-voltage insulation; and is the result of engineering effort of the highest order, utilizing all of the experience and skill available at this date.

"Thus is recorded another milestone of consistent development—of hydro-electric projects—of extensive transmission line building. The Gatineau line of the Hydro-Electric Commission is a monument to 20 years of service rendered by the Commission to the people of Ontario."

—*Digested from the Ohio Brass Bulletin.*

O.M.E.A. and A.M.E.U.

Convention at

ROYAL YORK HOTEL

TORONTO

January 29 and 30, 1930

Oxygen and Hydrogen in Industry

By W. P. Dobson Chief Testing Engineer and A. S. L. Barnes, Asst. Engineer, H.E.P.C. of Ont.

(Presented at Fifty-sixth General Meeting of the American Electro-Chemical Society, at Pittsburgh, Pa., September 19, 20 and 21, 1929.)

IF a text were needed for this subject, particularly in respect of oxygen, it could hardly be a better one than the following quotation from a paper on the "Use of Oxygenated Air in Metallurgical Operations," read in 1924 before the American Institute of Mining and Metallurgical Engineers : "Oxygen has never been produced at a cost low enough to permit its being used to enrich air for the purpose mentioned. If no cheap oxygen is in sight, why bother with the study of what could be done if it were available ? And the manufacturer of oxygen answers : Why waste time and energy in research for the cheap production of oxygen unless it is known that there will be a market for it when it is produced ?"

Thus we are on a sort of merry-go-round, but the going would be merrier if it were not rotatory.

World's Use of Hydrogen and Oxygen

The annual consumption of pure or relatively pure, oxygen throughout the world is probably about 5.5 billion cubic feet (156,000,000 cu. m.), but if oxygen as it exists in the atmosphere were included this figure would be multiplied enormously. Probably 100 billion cubic feet (28.3×10^{11} L.) of pure, or relatively pure, hydrogen are used annually in the world, and the demand is growing. This figure, of course, does not take into account the enormous amount of hydrogen which is contained in manufactured gas and other fuels ; of manufactured gas it forms about 50 per cent.

Oxygen. The case of oxygen, however, is different, since no outlets of large proportions have yet been developed. Oxygen is, at present, confined to a multiplicity of uses, all of them being such that the demand is relatively small and uncentralized. Distribution of this gas is therefore effected at comparatively high cost by means of cylinders, thus involving the expense of compression, as well as the provision, and also the carriage, of the cylinders, which of course are extremely heavy compared with the weight of the contained gas, and so add greatly to its cost.

Hydrogen. For hydrogen, at least one use has been found which requires immense quantities, that is, the manufacture of *synthetic ammonia;* while another, the hydrogenation of coal, seems to be on its way to commercial development on a large scale, Aside from the use of hydrogen made by the water-gas method, increasingly large quantities of electrolytic hydrogen are being consumed in the synthetic ammonia and hardening of fats industries.

In Italy, where coal is scarce and

water power fairly abundant, the *synthetic ammonia* industry generates its hydrogen by electrolysis and even obtains its nitrogen, in some instances at least, by burning hydrogen in air. Since the advent of the synthetic ammonia process for fixing nitrogen, several installations of electrolytic cells for the production of hydrogen have been built not only in Italy but also in Spain, Japan, Switzerland, Sweden and, quite recently, in Norway. Some of these installations are large, yielding thousands of cubic feet of hydrogen per hour (28.3 L. per cu. ft.). One installation is worthy of special mention.

In Norway, displacing the now almost obsolete Birkeland-Eyde arc process of nitrogen fixation, synthetic ammonia is to be produced on a large scale and electrolytic hydrogen will be used. About 140,000 kilowatts of hydro-electric power will be consumed in the synthetic ammonia process, and of this by far the greater proportion will be devoted to the production of hydrogen.

Possible Further Use For Oxygen on a Large Scale

All who have looked into the question of using oxygen are of the opinion that it could be utilized on a vast scale if its cost were low enough, and there seem to be at least two or three outlets for it which would in themselves create large, centralized demands. It goes without saying that the cost of oxygen, even if existing means of producing it were utilized, could be reduced appreciably provided that a very large demand existed at, or close to, the point of production. Further, existing means of production have not necessarily reached the highest possible efficiency and lowest cost. Undoubtedly difficulties lie in the way for those who would solve this problem of the low cost production and large scale utilization of oxygen, but the issues are not small and difficulties should be looked upon as an urge to, not a deterrent from, the overcoming of them.

One of the most important of the uses which have been proposed for oxygen, at least from the point of view of the size of the possible demand lies in the *enrichment of the air* supplied *to blast furnaces*. This question has been discussed by eminent experts for some years, with the result that many of them believe that considerable economies could be effected over present methods.

Other proposals worthy of consideration are the use of oxygen in the *production of water-gas*, by changing the present intermittent method of manufacture into a continuous process ; and the enrichment of air for combustion purposes in industry generally.

Possible Further Use For Hydrogen on a Large Scale

For hydrogen, although its use on a large scale is already an accomplished fact in many places, a possible major outlet would be in the *reduction of ores*.

Miscellaneous Markets

Mention has so far been made only of some of the larger actual and possible demands for oxygen and hydrogen such as, in themselves, create, or might create, a large

market. However, large scale production of these gases would also be possible if a number of smaller demands reaching a large total in the aggregate could be created in fairly close proximity to a central source of supply. Were these gases known to be available at reasonably low cost at some particular point there would be a tendency for those industries which could use them to locate in the vicinity, thus increasing the demand and lowering production and distribution costs.

Electrolytic Oxygen and Hydrogen in North America

There are several parts of the *United States* where, owing to the existence of natural conditions, it might be commercially feasible to use the electrolytic process for obtaining oxygen and hydrogen for various purposes if the gases were required in large quantities.

In *Canada* today over 90 per cent. of the electric power in use is generated from water power, and this state of affairs is likely to continue at least until the provinces of Alberta and Saskatchewan, with their vast coal resources, begin to make use of that fuel on a large scale for the generation of electricity. There is therefore an abundant supply of hydro-electric power, a proportion of which is "off-peak," and much more awaits development. In the Provinces of Ontario and Quebec there are no known coal resources of any significance, and electric power in these two great territories is in consequence practically 100 per cent. "hydro."[1]

It is clear that, if large scale uses for oxygen and hydrogen can be developed it is the duty of supply authorities to see that these gases are generated electrolytically if it be commercially feasible to do so ; and more especially so, if off-peak energy can be utilized, thus putting capital already invested to fuller use. Another reason why, in Ontario, we are giving consideration to these gases is that in the northwestern part of the province there are immense quantities of *low-grade iron ore*, which are awaiting the advent of some means of reduction cheaper than those at present in use elsewhere in order that such ores may, if possible, be utilized.

Two interesting announcements have recently appeared in the press. One is to the effect that the Consolidated Mining and Smelting Corportion of British Columbia will manufacture fertilizers, and is about to establish a large synthetic ammonia plant ; hydrogen will be obtained electrolytically. The other states that the by-product hydrogen of the Canadian Salt Company at Windsor, Ontario, is to be utilized in the manufacture of synthetic ammonia to be made by the Casale process. The Canadian Salt Company has recently been taken over by Canadian Industries, Ltd., which latter firm is an off-shoot of Imperial Chemical Industries, Ltd., of England. The synthetic ammonia will be oxidized to nitric acid, which will be utilized in the explosives factories of Canadian Industries, Ltd.

Why the Electrolytic Process is not More Used

It is pertinent here to inquire why the electrolytic process is not employed on a larger scale than it is

today. There seem to be several reasons, among which are the following :

Until comparatively recently no really large electrolytic oxygen-hydrogen cells have been available and the capital, labor and maintenance costs for small cells are relatively high. In the meantime other commercial methods of producing hydrogen (for example, the water-gas process) have been developed on an immense scale and, for oxygen the present uses are relatively small and by no means centralized.

The electrolytic process necessarily produces both oxygen and hydrogen, and, if only one gas be utilized and the other be entirely, or largely, wasted, all, or nearly all the cost must be charged against the one gas. Manifestly, in such case there would be great advantage in finding an outlet for the other gas.

Large quantities of power during periods of off-peak have not been generally available in the past.

Evidence is accumulating that several industries are taking an interest in the question of using oxygen and/or hydrogen in a large way, if only these gases can be obtained at low enough cost. It is recognized, of course, that there are various methods of obtaining oxygen and hydrogen, but electro-chemists and electrical engineers are naturally interested in the electrolytic process, and this paper is confined chiefly to consideration of the subject with which it deals, on the assumption that the gases are to be obtained electrolytically.

It may be pointed out also that, wherever coal is scarce and water-power is abundant, if use is to be made of either of these gases in large quantities the electrolytic method will be the one preferred, on account of these existing natural conditions. The present situation is that, usually, either hydrogen or oxygen alone is required, and the other gas is, (or is not), marketed as a by-product. If very large quantities of either gas were required and the electrolytic process were used, it might in any given instance be practically impossible to dispose of the large amount of the other gas thus made available.

The chief problen, therefore, where electrolytic production is involved, is to find a suitable outlet for oxygen, in bulk ; for, were it possible to establish a big demand for both gases near to a source of supply it seems likely that the price of each gas could be set at figures which would be reasonably satisfactory all round.

Advantages of Electrolytic Hydrogen

In the absence of a remunerative market for oxygen it is generally felt that, in large scale production, hydrogen can be obtained from water-gas at lower cost than by electrolysis, unless very cheap electric power is available. It is, however, so easy to obtain practically pure hydrogen directly from the electrolytic cell, that, where only a moderate amount of the gas is required, and gas of high purity is needed, the electrolytic method is often chosen, as, for example, in obtaining hydrogen for the hardening of fats and oils.

It is claimed, too, by at least one maker of electrolytic cells that the very pure hydrogen obtained can in

many cases command a higher price than hydrogen not quite so pure, in processes where the reactions depend on the presence of a catalyst. The reasons are that the catalyst will last longer, the speed of reaction can be increased, employment of lower temperatures and pressures is possible and a more sensitive catalyst may be used.

Large Electrolytic Cells For Oxygen and Hydrogen

Electrolytic cells for the production of oxygen and hydrogen are particularly suitable for operation with off-peak power, as they will work well at reasonable efficiencies, under great variations of load. Further, such cells accommodate themselves readily to rapid changes in load, as the demands on the system whence power is derived rise and fall. Hence, a load factor approaching 100 per cent. is possible of attainment. A large battery of these cells would furnish one of the best available means of filling up, not only daily, but also to some extent seasonal, valleys in load curves.

Any scheme or process which holds out a promise of enabling the load factor of electrical power supply systems to be appreciably improved is worth a good deal of study, because of the financial benefit which would accrue on the fulfilment of the promise. Also, assuming that there were a large and rapidly growing demand for off-peak energy the need for peak-load plants would be obviated.

Only those who have experimented with hydrogen-oxygen cells really know the difficulties that have to be overcome in developing any particular design of cell to a stage where it is fit to put on the market. Apparently there is still room for much research work before the ideal cell is evolved, which combines the greatest possible efficiency with longest life and the lowest capital, running and maintenance costs.

There are two main types of cell at present in use, the filter-press type and the ordinary tank type. Of the latter there are two variations, one using electrodes consisting of plain sheets of metal, and another in which each electrode is built up of a large number of metal strips laid side by side to form a grid. The active surface of such a grid are the edges of the strips plus the whole of, or at least a large proportion of, each side of every strip.

The inventors of this type of electrode claim increased output at the same efficiency, or increased efficiency at the same output, as compared with other cells, as well as reduced cubic content for equal capacity. Single cells capable of taking 10,000, 15,000 and even more, amperes can now be obtained. A 15,000-ampere cell will produce from 300 to 400 cubic feet of both gases, oxygen and hydrogen, per hour.

It is of interest to note that 100,000 kilowatts used for every hour in the year will produce about 6.5 thousand million cubic feet (184 million cu. m.) of hydrogen, and half that quantity of oxygen per annum. This is at the rate of about 750,000 cubic feet (21,000 cu. m.) of hydrogen per hour. The weight of hydrogen produced per annum will be about 18,000 short tons, and of oxygen about 130,000

short tons, (16,300 and 118,000 metric tons respectively).

Some particulars of different makes of cells were obtained, with a view to comparing them in this paper, but, unless a specific set of conditions of use is assumed, it is difficult to make comparisons. One of the most important factors about electrolytic cells is the voltage at which they operate. The voltage required for a given output varies, other things being equal, with the kind of metal used for electrodes, the electrolyte used, and with the temperature at which the cell is operated.

The material used for electrolytic cells seems to be, pretty generally, pure iron, with the anodes nickel-plated. The electrolyte is usually a solution of KOH in water. The temperature at which cells are run is mostly about 65° C., although higher temperature up to about 90° C. would be desirable if this could be obtained without detriment to the cell.

On the large installations both the water supplied to the cells and the temperature of the cells are controlled automatically, and little attention is required. Large batteries of cells of an aggregate capacity of 12,000 kw. can, according to one manufacturer, be looked after by one man. This would mean perhaps 400 cells of 15,000 amperes capacity.

The selection of cells for any given set of conditions involves careful consideration of several factors. The capital cost of the cells may be kept down by arranging to run them at relatively high voltage and current density, and space required and building cost will be less, but more money must be spent on the total electrical equipment required to furnish the current, including investment for generation, transmission, transformation, and conversion to d.c. If the source of primary energy (coal, oil, etc.) has to be paid for, the expense will be greater, because the cells will run at lower efficiency and will therefore require more energy supplied for a given output. These are conflicting items among which a balance must be struck in order to obtain the best commercial results.

Again, it seems quite probable that, for some specific case, one particular make of cell may have advantages, on account of efficiency or capital cost or other feature, not possessed by another make. Hence it would be as impossible to state off-hand that any particular make of cell would best satisfy any particular set of conditions as to declare, without proper investigation, what is the best operating voltage, in a definite case, for any one make of cell.

Before leaving this discussion of cells, mention should be made of the fact that several attempts have been made to operate oxygen-hydrogen cells under pressure, and in "Chemical and Metallurgical Engineering" of July, 1928, appeared an article by J. E. Noeggerath, describing a pressure cell which, it is claimed, uses about 25 per cent. less energy at 150 atmospheres than at 1 atmosphere. Small size and low cost are also claimed, as well as elimination of the need for compressors. A cell of this type, if it could be operated at the required pressure, would be useful, for example, in the synthetic ammonia industry, and for long distance transmission of the gases.

VIEWS OF EXPERTS.

Many authorities have expressed in the technical press and elsewhere views corrobative of some of the statements made above. A few quotations are here given :

ARTHUR D. LITTLE, INC.[2] "The justification of the use of pure oxygen in the combustion of fuel lies either in the very substantial saving of fuel that may result, or in the high temperature attainable. The available heat per pound of fuel burned, in high temperature work, may be several times as great when pure oxygen is used as when even a pre-heated air blast is used. This will result in marked economies in the production of high-grade ferro-silicon, ferro-manganese and ferro-chrome alloys that are indispensable in modern metallurgy. The smelting of iron, and especially of ferro-manganese, has already received favorable attention."

"In the field of processes requiring temperatures higher than are attainable by burning fuel with air, oxygen will probably invade a portion of the electric furnace field in a few years."

"Uses of an entirely different class, which may in some cases require a product of higher purity, are the chemical processes that use oxygen as a raw material."

"The outstanding example of such use is the possibility of blasting a water-gas generator continuously with a mixture of oxygen and steam."

"Such a generator might easily use 25 per cent. less fuel for a given output, and have twice the capacity from a given size of generator, due to continuous operation at higher temperatures."

"The direct result of economies along this line will be a rapid broadening of the field of gas utilization, both in house heating and in small industrial furnaces and boilers."

"Effective utilization in these various fields will depend upon well-supported and properly directed research."

F. G. COTTRELL.[3] "Use of oxygen in connection with the enrichment of the blast furnace and practically all phases of pyrometallurgical work will furnish the key to success in the further development of such metallurgical operations."

F. P. WILSON, JR.[4] "Oxygen is rapidly becoming as essential to industrial life as it is to human life ; and as new applications are economically perfected, it will undoubtedly rank with other forms of industrial utilities such as light, heat and power. It already has a great variety of industrial uses in its gaseous and liquid states, as well as in chemical combination with other elements."

USE OF OXYGENATED AIR.[5] "Many metallurgists believe that their operaations can be conducted more economically if they add oxygen to the air used in various smelting operations ; a number of chemists believe that relatively pure oxygen can be produced in metallurgical quantities at very small cost. If cheap oxygen could be produced, many metallurgical operations would benefit."

ELECTROLYTIC OXYGEN AND HYDROGEN.[6] "The plant (electrolytic) can operate satisfactorily and without undue loss of efficiency, under very great variations in the amount of power available. It is extremely flexible and the load taken by the battery can be instantly altered to

suit the power available according to the other demands on the generating station, so that a station load factor of nearly 100 per cent. can be obtained."

"The plant can be started and stopped instantly so that no time is lost on this account. The labor requirements of an efficient electrolytic plant are practically negligible, when it is equipped with automatic feed-water tanks which supply the make-up water according to demand."

[1] In some cases it might be feasible to develop new sites if a market for some of the power were immediately available, due to a demand for oxygen and hydrogen—sites, which, otherwise, it might not pay to develop for years to come. In Canada, the development of at least one large water-power site is said to have been made possible, or at any rate greatly facilitated, by the sale of current for the operation of electric boilers to supply steam required in pulp and paper mills.

[2] Cambridge, Mass., Industrial Bulletin, March, 1927.

[3] Chem. and Met. Eng., 30, 943 (1923).

[4] "The Application of Oxygen and Hydrogen to Industrial Operations," Gen. Elec. Rev., 30, 544 (1927).

[5] Abstracts of Papers presented at a symposium on Oxygenated Air at the New York Meeting of the Am. Inst. Mining and Metallurgical Engs., Inc., Feb., 1924, p. 4.

[6] World Power, Jan., 1928.

National Safety Congress

EACH year a National Safety Congress is held and is attended by representatives of the Hydro Electric Power Commission of Ontario. One would naturally ask : Why such a Congress is held ? During 1928, there were killed in public accidents in the United States, 48,000 persons ; in industry, 24,000 persons and in the homes, 24,000 persons. By organization, it has been clearly shown that accidents can be prevented and it is also clearly shown that accidents are the result of ignorance and carelessness. With an unnecessary loss of almost 100,000 persons each year, it is quite apparent why consultation and discussion should be carried out in an organized way, to reduce if not eliminate this waste.

One is at once impressed by the huge registration at the Congress, this year between 6,000 and 8,000. From large and small industries come General Managers, Engineers, Doctors, Managers, Superintendents and Foremen. There are also present Government officials, Insurance representatives, Police and Traffic Engineers, interested in preventing public accidents. With the success of the prevention of accidents in industry, it is but natural that social workers, nurses, school teachers, etc., are present to learn methods to put into effect, to reduce the appalling loss of life in home accidents.

The Sessions are generally divided into General Sessions of interest to all ; Industrial Section Sessions of particular interest to a given industry and Particular Subject Sessions of interest to various groups. In the Industrial Groups are found industries such as metals, mining, public utility, cement, packers, tanners and construction, etc. In the Particular Subject Groups, such matters as public safety, health, employees' publications, home safety, etc., were discussed. One was particularly impressed by the business-like conduct of the meetings ; the clear-cut and at times flatly contradictory

discussion and the quite evident intense interest of all attending.

In the opening Session, Dr. T. G. Soares of the University of Chicago in a thoughtful address pointed out that in the world of today, it is absolutely necessary for, from the toddler of three to the grandfather of eighty, to take particular care of ones movements to protect life and limb. The complicated industrial age we live in, is far different from that of 100 years ago. Telling the story of the Prince of Wales' reply to the request that he give up hunting, that it was his own neck he risked, the doctor asked the question—"Was it his own neck ?" Is any one a free agent or have not all of us many who are financially or emotionally affected, if we are injured or killed ?

In the Session dealing with automobile accidents, one of the automobile executives made out a case for more speed on the highways to prevent accidents, only to have Dr. Louis I. Dublin, Statistician, Metropolitan Life Insurance Company, entirely shatter his rosy picture, by clearly showing from recorded facts that speed is responsible for most of the highway accidents. In the Industrial Group, one of the outstanding matters of interest, was the presentation of a playlet of a series of meetings between a safety engineer and a hard boiled foreman, developing the thought that plainly it was more manly to prevent an accident than to think up an alibi afterwards. Through all of the papers and the discussions could be seen the thought that planning for safety will prevent accidents. This planning may mean safe design of plant, method of unloading a car of poles, safe guarding the public from an open trench or developing a set of safe operating rules. Unsafe methods and unsafe design have no place in modern economic practice was pointed out by a consulting business expert.

Good public relations, that most important of any successful public utility, it was pointed out, could not be developed nor maintained if the accident record is not kept to a minimum. In doing work on public highways, every precaution must be taken to prevent the public who have a perfect right on the highways, from becoming injured. One most striking evidence of the value of organized accident prevention work, was the elaborate and carefully planned programmes of accident prevention, carried out by the larger organizations.

The name Jane Adams, Hull House, Chicago, is known around the world. A life given in bettering the tenement liver. In a too short address, Miss Adams presented pointedly what it meant to the home to lose the breadwinner or to have a child scalded with water. This phase of the accident problem, is just now receiving attention. In the matter of health, an address by a General Foreman of the Western Electric Company, was of great interest. He gave the employees' reactions to the health programme of industry. Most employees took the health information passively or as it was put "To hold any job I have to take it so what the —." This clearly shows that much educational work with a clear-cut plan and no frills is needed.

The series of lectures on Public

Speaking by Professor C. D. Hardy, Northwestern University, Evanston, Ill., has for the last few years, been one of the outstanding events of the Congress. Starting at 8.30 each morning, with an audience of about 2,000, in a practical, humourous and thoughtful manner, Professor Hardy picked to pieces the average preconceived ideas of public speaking and presented many useful hints, a most important one being: "By practice, develop the habit of thinking on your feet."

The industrial age has increased hazards leading to accidents and ill-health. This price of the benefits of the industrial age being proved unnecessary, Accident Prevention is a recognized part of all industry and is needed in preventing public and home accidents. In matters of health, there is too much worry about ill-health and too little done to maintain good health.

A Little Nothing

He cut his hand, a little thing,
He hardly felt the sting,
He could not stop for iodine, so—
Five weeks in a sling.

He ran a splinter in his knee,
Why, what is that, I beg ?
He could not stop to fool with that,
The Doc cut off his leg.

He got a cinder in his eye,
Removed it with a knife;
He goes around half blind now,
But he's glad they saved his life.

He grabbed a piece of foreign wire
In quite a careless way,
The flowers were most pretty
At his funeral, they say.

He climbed to fix a cable,
On a ladder with a crack;
We're standing six feet over him,
He's flat upon his back.

We're always hoping for the best
When we should fear the worst;
It's best to tend the little things
With "First Aid" and "Safety First."

—*The Bluebell.*

Monsieur A. Antoine, Directeur Général de L'Electricité de Strasbourg was a recent visitor of the Commission. M. Antoine spent two days in consultation in the office and inspecting some of the Commissions plant. He showed a keen interest in the systems and more particularly was he impressed by the accomplishments made in developing an advanced system of inducement rates.

Mr. B. Mulholland, Assistant Engineer, Municipal Engineering Dept., left on the first of this month for six weeks visit to Ireland.

Hydro News Items

Central Ontario System

The Order-in-Council approving the sale of the Belleville and Oshawa local distributing systems and the Oshawa Gas Plant to the municipalities were issued in September. The Commission at the request of the municipalities will continue the operation of these systems until local commissions take office.

* * * *

Estimates are in preparation with a view to the supply of power to Hastings.

* * * *

The municipalities of Tweed, Napanee, Deseronto, Port Hope and Brighton have opened negotiations with the Commission with regard to the purchase of the local distribution plants.

* * * *

The council of the town of Cobourg is considering the submission to the electors of by-laws convering the purchase of the local gas, electric and water systems.

* * * *

Niagara System

Extensions and improvements are being made to London Transformer station. The building is being extended for a new control room, and the existing building changed to provide for additional feeders. Improvements are being made to the cooling water system and barrier walls erected around the 110 kv. lightning arresters. Improved type of relays are being installed on the London municipal feeders.

* * * *

Brantford Hydro-Electric System, on account of increase in load, is constructing a second substation in the northwest section of the city, one 3,000 kv-a., three-phase transformer being the initial installation.

* * * *

The American Can Company is constructing a can manufacturing plant at Simcoe and will take an initial load from the Simcoe Hydro-Electric System of approximately 350 h.p.

* * * *

In order to provide for substation capacity in the southwestern section of the city, St. Catharines Hydro-Electric System is installing a second substation with a capacity of 1,500 kw.

* * * *

A new rural office is being opened in Brampton, on November 1st, for the operation of the Brampton, Georgetown and Streetsville Rural Power Districts.

* * * *

A new rural office was opened in Guelph for the operation of the Rural Power Districts. Mr. J. E. Cornfoot, formerly in charge of Barton Township, is Superintendent.

Since last issue, instructions have been issued for the construction of over 56 miles of rural line in the Niagara District to give service to 134 consumers.

* * * *

Thunder Bay System

A third 110 kv. circuit with necessary interswitching is being added to the line between Cameron Falls generating station and Bare Point transformer station a distance of 68.4 miles. The conductor will be 336,400 cir. mils aluminum cable, steel reinforced and will be carried on the existing steel towers.

* * * *

The Commission is proceeding with the purchase and installation of 110 kv. switching equipment for the third incoming 110 kv. line at Port Arthur Transformer Station. The two present 110 kv. lightning arresters are being re-located and re-built.

* * * *

Hydro Shop Exhibit at Belleville Fair.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE LIGHTING SEASON

THE cool days and evenings of the Autumn act as a signal and a stimulant for a renewal of intense activity in practically all branches of life. The Summer recess has passed and just ahead are the productive months of the year merchants look forward to, the months when their sales are greater in volume of any season of the year and, of course, manufacturers must supply that which is sold. All this activity increases as the days become shorter until the peak of retail selling is reached just before Christmas. This involves the increased use of artificial lighting under which a very large percentage of the various activities are carried on.

During the Fall and Winter seasons manufacturers and merchants become aware of their need of better lighting, but it is a common thing for them to delay action until the beginning of the next season and that time is now. The value of good lighting in factory, office and store has been proved beyond doubt many times.

The first appeal to prospective buyers is the show windows of a store. The attraction of a well-lighted store window in which goods are tastefully arranged is irresistible. This, followed up by an interior lighted to correspond stamps the store in the public mind as a desirable place to shop.

The benefits of good lighting are none the less tangible in the factory and the office. By its use the employees are enabled to give much better service than is possible under poor lighting.

How is the lighting in your district? There are undoubtedly many men who have held over the relighting of their premises until after the Summer. The illumination laboratory of the Commission is equipped and ready to render assistance to those who feel that the lighting of the premises under their direction is not fully satisfactory. Lighting plans for either new or existing buildings will be supplied, a visit of inspection will be made when advisable. A few of the Hydro municipalities have availed themselves of this service, which is an indication that throughout the Province there is a great deal of this work to be done.

You are invited to refer the lighting problems in your district to the Illumination Laboratory, 8 Strachan Ave., Toronto, where each one will be individually considered and an impartial report submitted.

THE
BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Trethewey Falls Development

By S. W. B. Black, Hydraulic Dept. and N. F. Seymour,
Electrical Engineering Dept., H.E.P.C. of Ont.

THE application of "remote control" in the operation of hydro-electric power stations is making possible the utilization of many small water powers which otherwise would be outside the range of economic development. This method of control not only makes a marked saving in operating charges, but by centralizing the dispatching of the output of power in the hands of one operator, the most efficient use of the water is effected. This is particularly true where several developments are situated on the same stream.

One of the latest plants, with remote control equipment, recently put into commercial service by the Commission, is that at Trethewey Falls on the South Muskoka River. This plant lies immediately above the Hanna Chute station which was placed in service in October of 1926. Downstream again from Hanna Chute is the South Falls station where the control of all three plants is centralized. A total head of 170 feet is now developed on this stretch of the river.

The water discharged from the Trethewey Falls plant passes directly into the forebay or headpond of the Hanna Chute station, and that in turn discharges into the headpond of the South Falls plant. Very little pondage is available at Trethewey Falls or South Falls while Hanna Chute possesses a large headpond on which fluctuations in load are easily taken up without much change in level. It is thus evident, in order to obtain the most economical use of water by the three stations, that centralization of control is very desirable and necessary.

A very comprehensive storage system has been installed on the lakes above these three plants, the principal ones being Lake of Bays and Hollow Lake. The flow of the river has thereby been considerably improved by these storage reservoirs so that

CONTENTS

Vol. XVI No. 11

November, 1929

	Page
Trethewey Falls Development	377
Windsor, Essex and Lake Shore Railway	382
Measurement and Control of Diversion of Water from the Niagara River	385
North York Hydro	390
Demonstration at National Plowing Match at Kingston	391
The Use of Graphic Meters in Industry	394
Precautions Against Freezing of Fire Extinguishing Appliances	402
The Old Order Gives Place to New	405
A.M.E.U. Note	406
Hydro News Items	407

considerably greater loads can be carried by the plants than under natural conditions.

The natural head at Trethewey Falls was about twenty-four feet, and the development consists essentially of a concrete dam and power house across the river at the head of the Falls, which raises the water 11 feet, giving a total operating head of 35 feet for the plant. The dam consists of three stop log sluice-ways in the river channel, flanked by spillway sections seventy-five feet long on either side, and a wing wall on the west bank extending from the power house to the high ground above. The power house substructure is of re-inforced concrete construction, and contains one 2,300 horsepower turbine at 257 rev. per min., with propeller type runner, which was supplied by S. Morgan Smith-Inglis Company, Limited. A short tailrace channel carries the water across a neck of land to the pool level below. The unit is controlled by a Woodward governor having the necessary automatic and remote control attachments to enable operation from South Falls. A head-water gauge similar to the one at Hanna Chute is being installed with a duplicate recording instrument at South Falls. Thus the chief operator can keep track of the water levels at the three plants and balance the loads to derive the most benefit from the water supply.

A gantry crane of five-ton capacity is installed on the headworks deck for handling the racks and the steel sectional gates ; these gates may be used for unwatering the turbine pit.

The new headwater level required the raising of one highway bridge about six feet, and over a mile of road to a maximum height of three feet.

Upstream view of Trethewey Falls development.

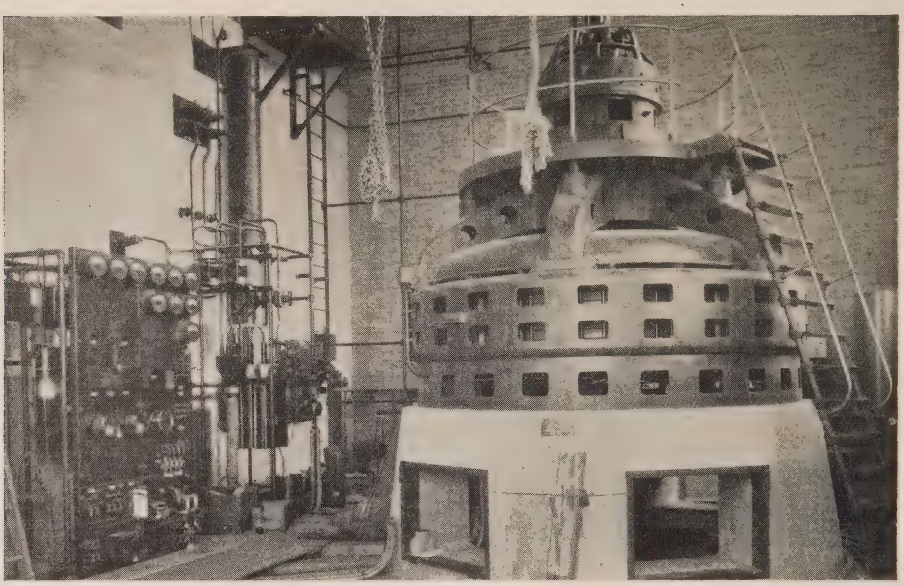
Down-stream side of Power House.

A timber log slide has been provided immediately adjacent to the power house.

The superstructure of the plant is of pressed brick construction, 36 ft. 6 in. by 29 ft. 6 in. by 33 ft. 2¾ in. high, and is designed to house one generator with its switching and automatic equipment. A roof monitor 7 ft. by 4 ft. 6 in., and three wall louvres below the windows on the down stream side of the building are provided for the proper ventilation of the power house and generator. A fifteen ton, hand operated chain block is installed in the building for the erection and dismantling of the unit.

The generator installed in this plant is a Swedish General Electric Company vertical type machine with a spring type thrust bearing to carry the weight of the rotor and the turbine runner. The rated capacity of the unit is 2,000 kv-a., 80 percent. power factor, 3 phase, 60 cycle, 6,600 volts, 257 rev. per min. The lubricating system of the machine is self-contained, the oil being circulated by a pump, driven off the generator shaft, from the reservoir of the lower guide bearing to the thrust bearing chamber and from there by gravity to all other bearings. The thrust bearing operates in an oil bath which is kept well supplied with cool oil when the oil valves have been properly adjusted for normal speed. The oil after leaving the oil pump is passed through a water cooled oil cooler located on the generator room floor outside the generator concrete base ring before it enters the thrust bearing. The water for this cooler as well as for general station supply is taken from the forebay through a pipe embedded in the centre pier into the power house.

This unit is also designed for self synchronizing and is provided with a 95 per cent. speed contact which



Interior View of Power House.

automatically closes the breaker and places the unit on the line when the master starting element has been closed.

No step-up transformers are provided at this plant, the power developed being fed at generator voltage (6,600 volts) direct to the South Falls station bus. The length of this line as well as the control cable for this station is 2.4 miles. This voltage is stepped up at the South Falls station to system voltage (22,000 and 38,000 volts) by means of the main power transformers which have been provided to handle this additional capacity.

A bank of two 5 kv-a. and one 15 kv-a. service transformers is installed in the station to step the voltage down from 6,600 volts to 110-220 volts for the supply of all motors used in conjunction with the automatic features as well as control, lighting, heating and cottage service at the plant. All direct current control service used at this plant is supplied from the main direct current control bus in the South Falls station.

One 6,600 volt, 3 phase circuit is constructed between the Trethewey Falls and the South Falls plants which acts as both a service feeder and a generator feeder. This line is provided with an automatic breaker in both plants with the service feeder for Trethewey Falls tapped off the line side of the breaker in this plant. The circuit breaker used in Trethewey Falls is a motor operated type of Canadian General Electric manufacture.

The automatic control of the unit in Trethewey Falls is installed in the South Falls plant while manual control for emergency conditions can be carried out in the Trethewey Falls station. All control and indicating

wiring is supplied between these plants by means of a 24 conductor lead covered cable carried on the same poles as the power feeder at a distance of from 5 to 10 feet below the power feeder and carried into both stations through a set of telephone protective devices consisting of 14 ampere fuses and carbon blocks for grounding excessive voltages which might be induced in this cable due to short circuits on the power feeder.

All load and power factor indications are recorded at the South Falls plant and once the unit has been placed on the line the operators in South Falls have control over the generator by means of push pull buttons to vary the speed and voltage of the unit. Consequently the operators in South Falls are able to manipulate load conditions on South Falls, Hanna Chute and Trethewey Falls plants to pass sufficient water for the system load without wastage.

In starting up of the machine the operator has only to pull a pull button switch in South Falls station which closes the master element and the unit is automatically put in service, thrown on the line and brought up to voltage and the operator can then load the machine as desired, by means of his speed and voltage control. The plant is normally shut down by reducing the load by means of the speed and voltage control buttons and then pulling another pull button switch in South Falls plant which automatically opens the breaker and the master element and the automatic sequence on the governor and control devices at Trethewey Falls shuts down the unit and applies the brakes. These brakes are of the oil pressure type and although automatically applied by the governor are arranged for hand pumping.

In cases of trouble the unit is promptly cleared from the system by relays provided for this purpose and the plant shut down automatically. In addition to the protective devices normally supplied in manually operated plants this unit has the following which are in two classes :

(*a*) Relays which clear the unit from the system and shut the plant down which will allow the immediate re-starting of the unit without inspection if desired, as follows :

(1) Alternating current overvoltage relay which shuts down at 25.5 per cent. overvoltage.

(2) Direct current overvoltage relay which shuts down at 11.2 per cent. overvoltage.

(3) Low governor oil pressure relay which shuts down when pressure drops to 140 pounds. Normal operating pressure, 160 to 200 pounds.

(*b*) Lock-out relay which clears the unit from the system and locks out the plant when the trouble must be remedied and this lock out relay hand reset before the unit can be started up again. This relay is operated from :—

(1) Thermostats of the dial type on all bearings which operate in case of excessive heating of any bearing.

(2) Overspeed mechanical device on the generator which operates at 19 per cent. overspeed (305 rev. per min.).

(3) Differential relay which operates on generator differential.

(4) Direct current undervoltage relay which closes its contacts if the exciter voltage drops to 25 volts.

The complete switching and control apparatus was arranged by the Commission's Engineers. Standard contactor switches and relays and special relays were purchased from the different manufacturers and connected in to meet the desired operation and protection for this plant.

This station was placed in active service in September of this year, about one year after the commencement of construction operations by the Construction Department of the Commission.

Windsor, Essex and Lake Shore Railway

By W. R. Robertson, General Superintendent, Hydro-Electric Railways

IN February, 1927, representatives of the municipalities served by the Windsor, Essex and Lake Shore Rapid Railway met at Kingsville to consider the proposed abandonment of the railway by its owners. This meeting adopted a resolution requesting the Commission to prepare a valuation of the railway and an estimate of the cost of rehabilitation and operation by the municipalities.

The Commission's engineers reported that the road could be purchased for $296,000.00 and that complete rehabilitation would cost $704,000.00. Earnings based on the actual earnings for the year 1926, and an increase in local earnings in Windsor from district now served by buses, were estimated at $285,000.00 with operating expenses at $173,000.00 and annual fixed charges for depreciation, interest and amortization at $110,000.00.

The proposition was placed before the electors of the interested municipalities and ratified, and legislation was then secured authorizing the formation of a Municipal Association to acquire the railway, with authority to transfer the control, rehabilitation and operation to any railway operating in the County of Essex.

The participating municipalities formed an association known as the Windsor, Essex and Lake Shore Electric Railway Association, with one member from each municipality and Mr. E. Blake Winter, President, Mr. W. B. Clifford, Vice-President, and Mr. M. E. Brien, Secretary. The Association floated bonds for $1,100,000.00 to cover purchase and rehabilitation and working capital of $100,000.00 and purchased the railway. Proceeds of bond sale amounting to $684,000.00 was turned over to the Commission to cover rehabilitation.

On September 8th, 1929, the Commission, under an agreement with the Association, took over the operation and rehabilitation of the Railway.

The Railway consists of 36.12 miles of standard gauge single track, extending from the corner of Pitt and

Map of Essex County showing route of Windsor, Essex and Lake Shore Railway.

Ouellette Streets, Windsor, to Leamington, with sidings to many thriving industries along the route. The district traversed is one of the most prosperous in Ontario, with extensive production of fruit, vegetables,

Bathhouse at Point Pelee Park.

Point Pelee Inn at entrance to Point Pelee Park.

tobacco, and general farm produce.

At present, power is generated at a steam plant in Kingsville, and alternating current at 6,600 volts is used direct on the trolley wire. This entails the use of very heavy equipment of a type expensive to maintain. Cost of operation has necessarily been very high, and with unusual expenses in correcting defects in equipment and converting boilers from gas to coal-burning, has resulted in such a financial condition that the old company could not finance improvements, and the property was allowed to become rundown.

To rehabilitate the road, the Commission will change from steam-generated to Niagara power, put in

Lighthouse at Leamington.

modern, high-speed cars and reconstruct the roadbed and overhead system. These improvements are estimated to cost $674,000.00 made up as follows : reconstructing road bed with new sidings, telephone and block signals, new overhead, new freight shed, Leamington, and repairs to stations, $444,000.00 ; five new and three re-built passenger cars and two locomotives, $155,000.00 ; and three new sub-stations, $75,000.00.

When the rehabilitation is completed, the road will be in a position to give a much better service at a greatly reduced operating cost. In the past, traffic has been offered which the road could not handle for lack of equipment. This, and much new business should be attracted by the improved service, with resultant increase in earnings.

A start has been made on the rehabilitation programme. About 20,000 ties have been put in the track, the roadbed in Windsor improved, and work on the joint transmission line for the Power Department and Railway is under way. By Spring it is expected the new cars will be running, providing adequate facilities for handling increased traffic.

Measurement and Control of Diversion of Water from the Niagara River

By J. J. Traill, Assistant Engineer, Hydraulic Dept., H.E.P.C. of Ont.

TWENTY years have elapsed since the Boundary Waters Treaty between the United States and Great Britain was signed, determining among many other important matters, the amount of water that might be diverted from the Niagara River for the development of power. By the terms of the treaty, there may be permitted a diversion from the river within the Province of Ontario, for power purposes, not exceeding in the aggregate 36,000 cubic feet per second, and within the State of New York 20,000 cubic feet per second.

Three large power developments were in process of construction on the Canadian side at the time that the treaty was signed. The Canadian Niagara Power Company, a subsidiary of the Niagara Falls Power Company, commenced the construction of their plant in 1901. Power was delivered in 1905, and by 1917 ten units, having an aggregate capacity of 109,000 horse power, were installed. In 1902 the Ontario Power Company commenced work on what is now the Ontario plant of the Hydro-Electric Power Commission. Power was first produced in 1905, and by 1913 fourteen units, having an aggregate capacity of 180,000 horsepower, were completed. Two additional units were added in 1918. Finally, the Toronto Power plant was commenced in 1903, first delivered power in 1906, and was completed in 1915, with eleven units having an aggregate

capacity of 145,000 horsepower. Construction and operation of all of these plants thus commenced a few years before the treaty was signed in 1909, and all were completed a few years after that time. Only one existing plant antedated these large developments, namely that of the International Railway Company, begun in 1892 and completed in 1905, with a capacity of 3,600 horsepower.

These four plants, as finally brought to completion, were incapable of using the whole permissible Canadian diversion under the Boundary Waters Treaty, even had they operated at full load continuously. It was therefore quite unnecessary at that time to keep continuous records of the water used, and no systematic inspection or test of the plants was made by Dominion Government officials concerned with adherence to the terms of the treaty. The Spring of 1922, however, saw the first unit at the Queenston plant come into service, and as additional units were added and plant output increased, it was evident that the time was not far distant when the whole permissible diversion of 36,000 cubic feet per second would be in use. A similar situation existed on the American side of the river, where a large extension of the plant of the Niagara Falls Power Company was in process of completion.

In 1923 an agreement was reached between the United States and Canada, whereby an International Niagara River Board of Control was appointed, charged with the inspection of the various plants on each side of the river for the purpose of ascertaining definitely and accurately the quantity of water being used in each country in view of the limitations imposed by the Waterways Treaty.

At the request of the Board, the Commission's engineers carried out many tests of generating units, conduits, penstocks, and other parts of the plants, and devised a method of rating the units or groups of units so that measurements of the energy generated could be used to determine the amount of water diverted. It is obvious that the primary requirement would be accuracy and, for this reason, methods of procedure in the tests and subsequent investigations were subjected to the closest scrutiny. It was to be expected too that the Board would require similar methods to be used on both sides of the river, and this was quite possible, as all plants are similar in this respect, namely that in almost all cases each unit is supplied by an independent penstock. Accurate measurements of large quantities of flowing water are always difficult, but this feature of the plants makes for a very convenient application of the Gibson pressure-time method of measurement. It is beyond the scope of this article to describe this method even briefly, but it is doubtful if more accurate results could be obtained by any other method in such installations as those at Niagara Falls. It was unnecessary to test each unit, but many tests were made of identical units, thus providing checks on the accuracy of much of the work. In all, twenty different units were tested in the three plants, and tests were also made on conduits, tunnels, penstocks and other parts of the hydraulic installation, as well as careful checks

of many of the electric instruments. All tests were witnessed by members of the Board, or their deputies.

In addition to this, the engineers of the Board kept in touch with all work done in the preparation of the rating tables based on the tests, and checked the computations before approving of the results.

From the standpoint of the Commission, it was essential that the method of deriving the water diversion from the records of load on the plants should permit quick and accurate conversion of the power readings into equivalent water used. It was only a few years after the reports on diversion were first prepared until the whole permissible diversion was required to meet the load demands, and by having records prepared quickly it was possible to take full advantage of all available water.

The procedure in computing the water diversion is as follows: Promptly at the end of each hour an operator in the control room of each plant reads the kilowatt-hour meter on each generator, and reports his readings immediately to the load despatcher's office at the Ontario plant, along with such other pertinent data as headwater and tailwater elevations. Here the load records are converted into water diversion records by the aid of the rating tables referred to above. The load despatcher is also advised regarding operation of auxiliary equipment or other equipment using water, and makes allowance for all miscellaneous uses of water. In a very few minutes after the close of the hour, the load despatcher has before him the record of water used for the preceding hour, and also the total amount for the day up to that time. It thus becomes possible for him to so control the load on the various plants as to make full use of the whole available diversion and yet not exceed the limit of 36,000 allowed to Canada. This diversion, of course, supplies the Canadian Niagara Power Company and the International Railway plant, as well as those belonging to the Commission. The former, by its charter, may generate only 100,000 horsepower, and usually has a daily load factor of 99 to 100 per cent. for six days each week. It is easy, therefore, to make allowance for the water used by this plant, and, as the International Railway plant is relatively small, errors in the estimates of the diversion at this plant are not of great importance. Accurate records of diversion at each of these plants are, of course, obtained by the Control Board.

The diagram in Fig. 1 illustrates the closeness which the load despatcher can obtain between the permissible and actual diversion. It will be observed that in the month selected, which is quite typical of ordinary operation of the plants, the diversion for power purposes was nearly always very close to 36,000 cubic feet per second on each day. The exceptions are Sundays, when, of course, the system demands are so greatly reduced as to make it unnecessary to use all of the available water. The opinion has been expressed occasionally, by those not well informed, that the permissible diversion is being exceeded. Such statements are absolutely without

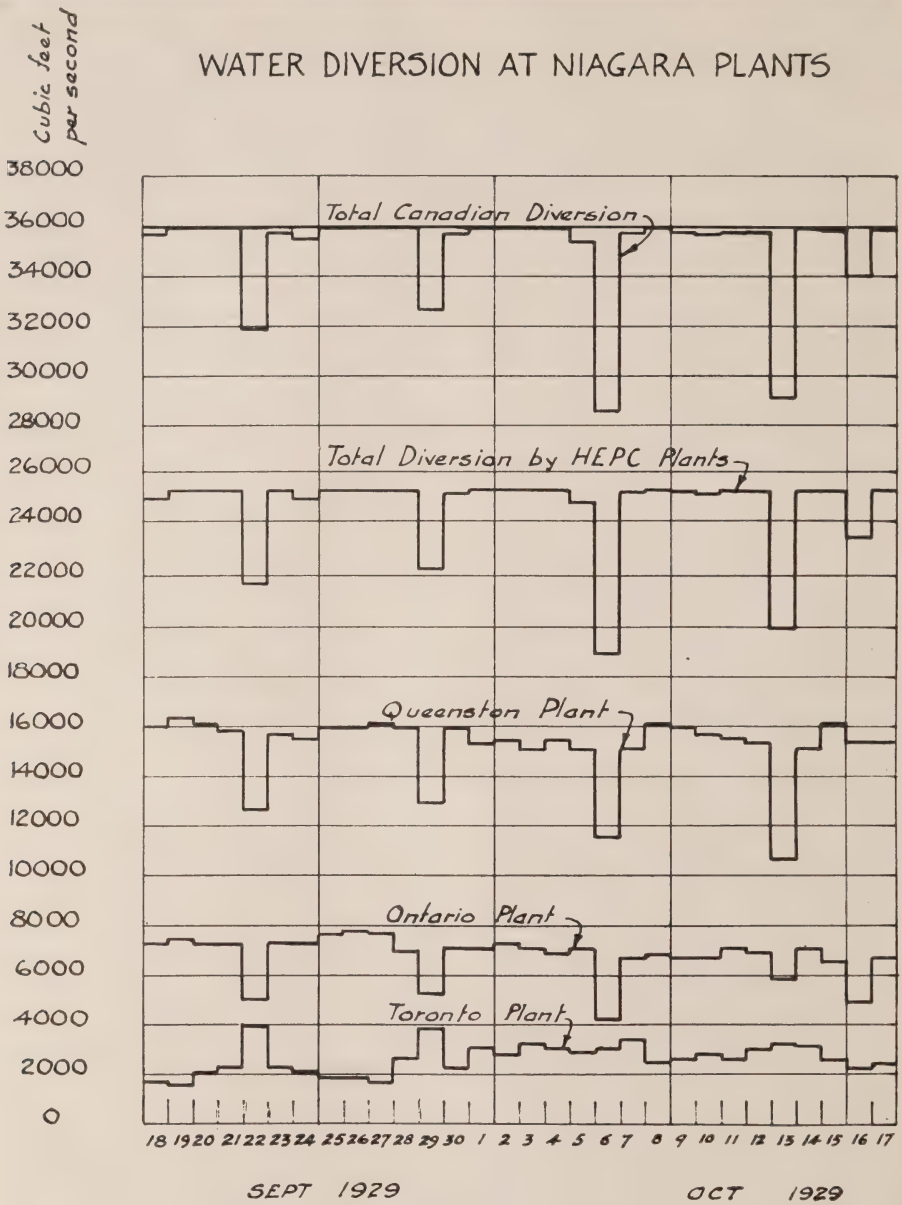


Fig. 1

foundation. In the recorded diversions, in addition to the allowances made for water required to generate power, full allowance is also made for the water used by service units, the water used by units running without load but ready to go into service, for leakages, and for flushing ice and debris as at the ice chute gate at Queenston, so that the spirit, as well

as the letter of the treaty regulations, is carefully lived up to. Of course, every attempt is made to reduce leakage and other water used that is not productive of power for system or service.

In the design of the Queenston development, one of the ideas constantly before the Commission and its engineers was that a plant of high efficiency, using as much of the available fall in the Niagara River as possible, should be built. The result, as is well known, is a plant with units having an overall efficiency of 91 per cent. and generating 30 horsepower for every cubic foot per second of water flowing through the plant. As compared with this, the Ontario plant, also a very efficient plant but which works on a lower gross head, generates 17½ horsepower per cubic foot per second, and the Toronto Power plant, operating under a still lower head than the Ontario plant, generates only 9½ horsepower per cubic foot per second. It is important, therefore, that as much energy as possible should be generated at the Queenston plant on account of its greater water economy, and this is attended to by the load despatcher, the plant being run at a very high load factor and carrying, day and night, as much of the system load as possible. In the early hours of the morning, as the system load grows, the Ontario Plant load is increased, and when the demands exceed the capacity of these two together, additional load is carried by the Toronto Plant. By this arrangement, as much energy as it is possible to obtain is procured from the permissible diversion.

In the month's records illustrated in the diagram, the average daily diversion at the Queenston plant is usually in the neighborhood of 16,000 cubic feet per second ; at the Ontario plant it is seen to be about 7,000, and at the Toronto plant about 2,500 cubic feet per second. The average loads corresponding with these figures would be 480,000 horsepower at Queenston, 120,000 horsepower at the Ontario plant, and 24,000 horsepower at the Toronto plant. The peak loads, of course, exceed these figures for average load, and the daily load curves for the plant would show that only peaks in the daily load are carried by the Toronto plant, on account of its low water economy of course. Generally, for about seven hours commencing about 11 p.m., the plant carries no load. Thus, no more of the diverted water is used at low efficiency than necessary, and the fullest benefit possible in power produced accrues to the Province from the water diverted.

North York Hydro

NORTH York Hydro Electric Commission has recently completed and occupied a new office building, at 5151 Yonge St., Willowdale. Previously it had used rented quarters in the North York Township building. This is the second building built by North York Hydro, the store house located at the rear of the new office building having been erected in 1925.

The Hydro-Electric System of North York Township has its origin from three sources, namely: The Toronto Electric Light Company and its affiliated organization, the York Radial Railway, extended distribution lines north and east from the City of Toronto into what was then York Township; The Toronto Hydro-Electric System built a few lines north and west from the City and the Town of Weston co-operating with the Ontario Commission extended its lines east and north into the Township, beginning in the early part of 1914.

In 1923 after the secession of North York from the rest of the Township, steps were taken to form two separate system areas. Area No. 1 took in roughly the section between Bathurst Street and Bayview Avenue and extending from the southerly to the northerly limits of the Township. Area No. 2 was made up of the section immediately to the north and east of Weston. At this time the combined areas were serving some 300 customers, with a total plant value of about $65,000.00.

In the spring of 1927, Area No. 1 was enlarged to include all but the extreme northeasterly and the extreme northwesterly sections of the Township and absorbing Area No. 2. The combined plant at this time had reached a cost of some $260,000.00 and was serving about 1,750

North York Hydro Commission's new office building.

customers. The system now serves more than 2,400 customers and has an investment in plant of over $280,000.00..

From the time of forming the areas in 1923, the System has been under the management of North York Hydro-Electric Commission. The officers of this Commission for the year 1929 are Messrs Robert Risebrough, Chairman ; H. V. Bowden, Commissioner, and James Muirhead, Reeve. Mr. Thomas Jackson is Superintendent, having filled that position from the beginning, and Mr. B. Thackeray is Secretary.

Demonstration at National Plowing Match at Kingston

THE Commission this year again made a demonstration of equipment which might be used on farms, housed in two tents so as to make the assembly clearly defined as to that which might be used in barns and dairy and that which might be used in the household.

A variety of ranges, washing machines, refrigerators and appliances were on display in the household section. The selection was made so as to cover as far as possible as complete a line as space would permit. There were seven ranges, seven washing machines, three refrigerators and two water heaters, besides the table appliances, set up in this section.

The space in the barn section would not permit making a complete assortment of the farm machinery which might be driven by Hydro-Electric power but a sufficient number of pieces were assembled in this section to present the idea of driving equipment from a central source, *i.e.*, with a line shafting, and those interested in power could easily imagine other equipment assembled in such a way as to be driven from this same power source.

In the dairy section a line shaft was driven by a one-horsepower motor

Fig. 1—Installation in the Household Section.

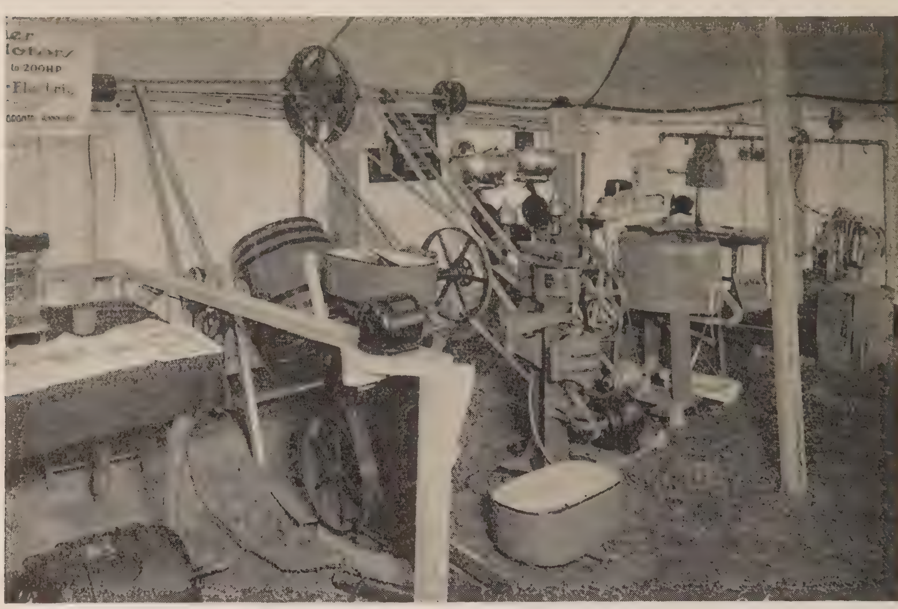


Fig. 2—Dairy and Motor Information Section.

and to this were belted two makes of cream separators, a churn and a washing machine. A deep-well pump head was also installed in this section as the uses of water are so closely allied with the dairy. A washing machine was also installed here as on many farms it is more convenient

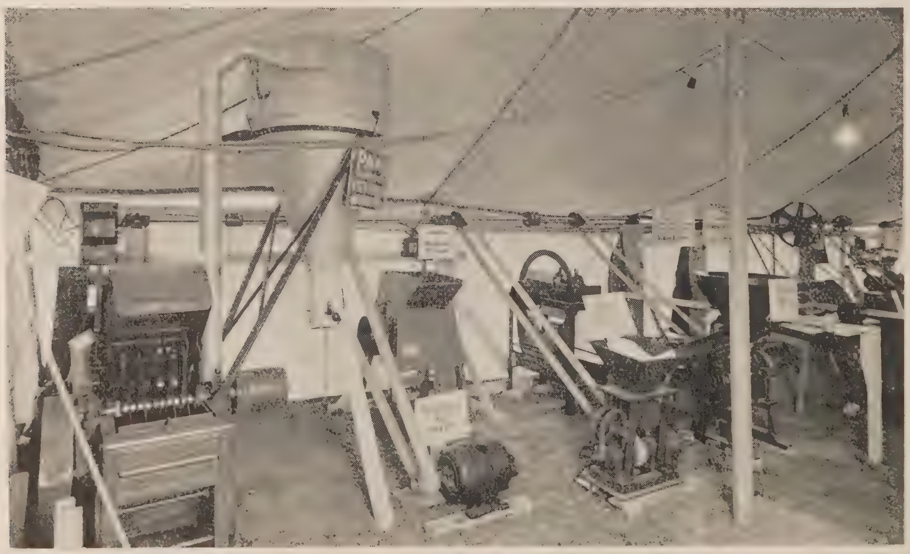


Fig. 3—Barn Section.

Fig. 4—Demonstration of Water Systems.

to make use of the motor which drives dairy equipment to supply power also for a belt-driven washing machine. The milking machine demonstration unit in this section properly belongs in the barn but being a part of the installation on a dairy farm it was included in this section, as the two are so closely allied in the operation of dairy farms.

Fig. 1 shows the installation in the household section, with a view through the passageway into the barn and dairy section.

Fig. 2 shows the dairy section and motor information sections.

Fig. 3 shows the barn section.

Fig. 4 shows a variety of water systems.

The estimated attendance at the Plowing Match during the four-day period was 35,000. Of those in attendance great numbers passed through our demonstration tents.

Complimentary remarks were heard from many. Among those noted as making these remarks were—Dr. Christie, President of the Ontario Agricultural College, Guelph ; Mr. Bert Roadhouse, Deputy Minister of the Ontario Department of Agriculture, and representatives of the Agricultural Department at Ottawa.

It would seem from the interest taken by the farmers and residents of rural districts in attendance at the plowing match that much of the equipment on display would find a place on the Hydro-Electric equipped farm and home.

The Use of Graphic Meters in Industry

by A. R. Wells, Meter Engineer, Operating Dept. H. E. P. C. of Ont.

(Continued from October)

Fig. 11 shows a Graphic Meter of the termo-demand type. This meter is comparatively new and has shown itself to be particularly useful for certain purposes, principally the recording of badly fluctuating loads where the value of the load obtained is desired to be easily readable or to be the equivalent of the heating produced in the motors driving the load. Since there are few fluctuations in the slow moving pen it is possible to run the paper at a much slower speed, thus reducing the paper cost and also increasing the reliability of the operation of the paper driving mechanism. This latter feature is particularly valuable when in remote, unattended stations, some of which are of the outside variety. This all sounds very well until it is desired to caliberate one of these meters on a cold day at an outdoor station, when it is realized that the load must be held steady for 20 minutes to obtain the caliberation at one point of the scale.

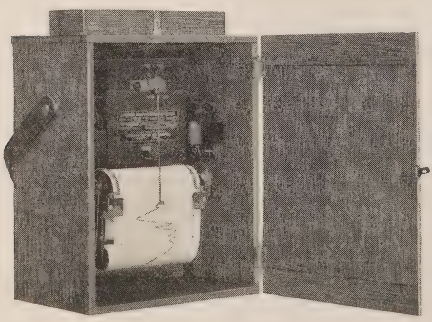


Fig. 11—Thermo-demand type of graphic meter.

The moral is, don't caliberate a meter of this type at an outdoor station on a cold day.

The type of pen in this meter is not new, but the fact that the pen moves very slowly makes it possible to run for a considerable time on one filling. It has been found that when using half-inch per hour paper speed one filling of the pen will last a month. This meter can be obtained with either clock drive or equipped with a small synchronous motor. The meter with the half-inch per hour drive by a synchronous motor has been found to be a particularly reliable meter from the point of view of continuity of records.

As previously mentioned, the fact that the meter is in the thermo-demand type makes it possible to use it in measuring the average values of particularly variable loads, but this feature makes the meter useless when measuring the values of rapidly changing quantities, unless only the average value and their effect in regard to heating of the electrical equipment supplying the motor.

This type of meter is certainly the lightest of the strip-type recorders, which is a great advantage to the person who actually carries the meters around.

Fig. 12 shows one model of the cheaper variety of Graphic Meters in which the chart used is of the round variety, which must be changed at the end of the period or the record of the previous period is destroyed and no record is obtained for the

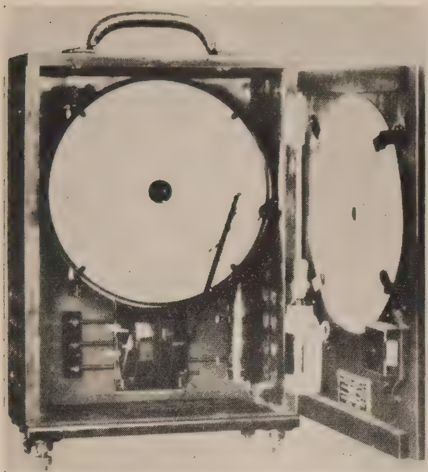


Fig. 12—Graphic meter using circular chart.

period between the time the chart should have been changed and the time it is changed. The strip-type meter has the decided advantage that the period between changing charts is much longer, and even though the paper runs out all of the record on that chart is still useful, and the only chart loss is between the time the meter should have been attended to until the time it is attended to.

Fig. 13 shows the instrument designed to record the time and duration

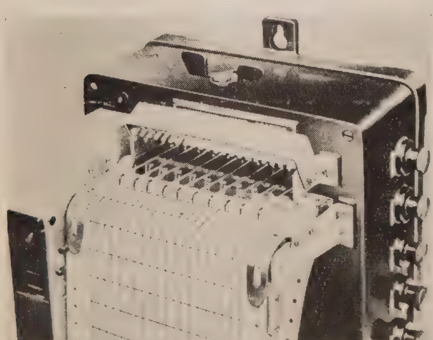


Fig. 13—Graphic meter to record the time and duration of ten different events.

of ten independent events. The number 13 makes the writer think of the good luck the operator would require for the ten pens to all continue inking between the time of one visit and the time of the next.

The manufacturers state that it is possible to lift each of the pens out of the meter without disturbing any of the others. This meter, as will be seen, is driven by hand wound clock at speeds which can be changed by changing gears on the side of the clock. The re-roll in this type of meter is driven by a separate spring in the clock case, thus keeping a constant pull on the paper. The writer has not had any experience with the operation of this particular meter.

Fig. 14 shows a direct acting Graphic Meter which has been provided with what is called a quick-trip attachment. The purpose of this meter is to obtain a record of normal events on a chart having a comparatively slow paper speed, but on the occurrence of any desired event to

Fig. 14—Graphic meter provided with quick-trip attachment.

increase the speed of the paper to quite a high value, in order to obtain a record of the quickly changing events during the time of an unusual disturbance.

The quick-trip attachment has to be reset and re-wound after each operation. One manufacturer has devised a meter in which the paper is driven forward at the high speed by a motor which runs continuously and is so arranged that the paper is driven forward exactly twenty-four hours on the chart each time the quick-trip device operates. With the high paper speeds the pull of the paper on the pen is sufficient to move the pen off zero by a considerable amount, and it is only when the pen is at mid-scale that the speed of the paper has no effect on the position of the pen.

Characteristics of Meters

Damping.

The characteristic of meters which determines the legibility of the chart more than anything else is damping. A meter is said to be underdamped when the pen moves beyond the final position when the load is changed, and then has to return to it after it has had one or more complete oscillations. A meter is said to be critically damped when the pen just reaches the true value and neither overshoots nor is exceedingly long in reaching the final point. Fig. 15 shows the effect on legibility of the chart produced by damping. Whether the chart showing the maximum swings was taken on a meter having less than critical damping or not is not stated in the catalogue from which the diagram was taken, but since most of the earlier Graphic Meters of the direct

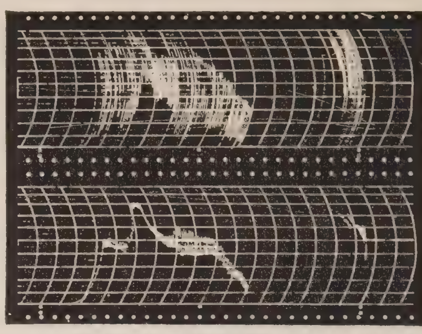


Fig. 15—The improved legibility of a chart produced by damping.

acting type were underdamp, it is quite probable that the upper chart is for an underdamp meter and that the lower chart is for an overdamped meter. Where it is possible to adjust the damping in a meter which is to be used to record rapidly varying quantities, it is necessary to adjust the meter for just under critical damping in order that the pen may reach the final position in the minimum time.

Fig. 16 shows very clearly how much more information about the instantaneous values of rapidly changing quantities can be obtained by high paper speed. Several things affect the accuracy of the chart at the high paper speed. Damping is all important, and the accuracy with which the occurrences can be recorded is entirely dependent on the damping. In one type of Graphic Meter it has been found by test that if a disturbance lasted for 0.2 seconds a meter moved to 50 per cent. of the distance between the original and the true final position. If the disturbance lasted for 0.7 seconds, the meter can move 90 per cent. of the final distance. From this it will be seen that the values recorded on the chart shown

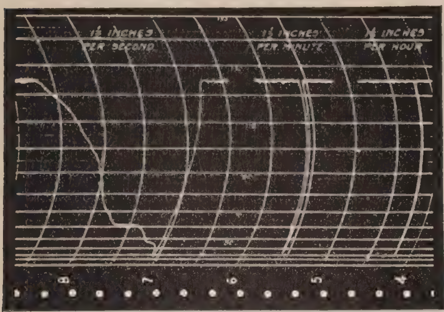


Fig. 16—Chart taken with high paper speed showing instantaneous values.

when the paper is moving one and one-half inches per second, would have to be corrected for the time lag of the meter. However, considerable information can be obtained from these high speed charts.

Figs. 17 and 18 show the character of chart obtained from a relay type of meter, and a thermo-demand type of meter on the same load. The writer is familiar with the damping on the relay type of Graphic Meter from which the charts were taken, and knows that they were very heavily damped, so that it would require at least 30 seconds for the pen to move from zero to full scale. If the damping had been any lighter the pen would undoubtedly have cut through the paper.

Fig. 19 gives a good idea of the type of charts which are used on the various meters for measuring electrical quantities. The top figure shows the typical volt meter chart of an alternating current Graphic Volt Meter. Since the voltage does not vary to any great extent, the zero is suppressed and the normal operating point is made in the centre of the scale. As will be noted, the scale is not uniform. The second specimen of chart is a typical one for direct current instruments, and for watt

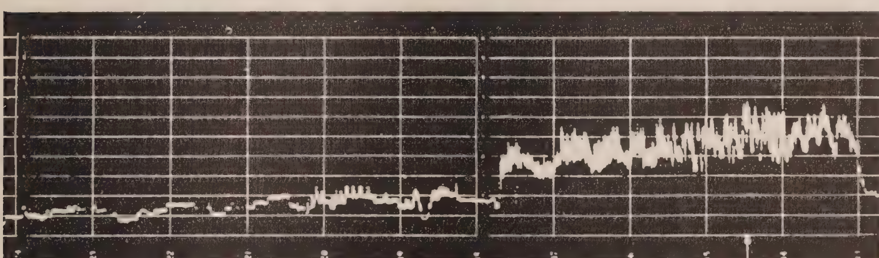


Fig. 17—Chart made by relay type of meter.

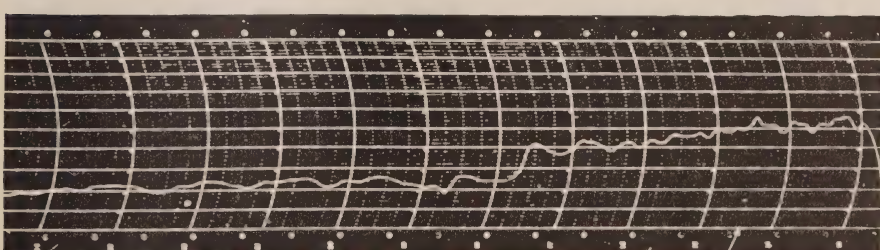


Fig. 18—Chart made by thermo-demand type of meter.

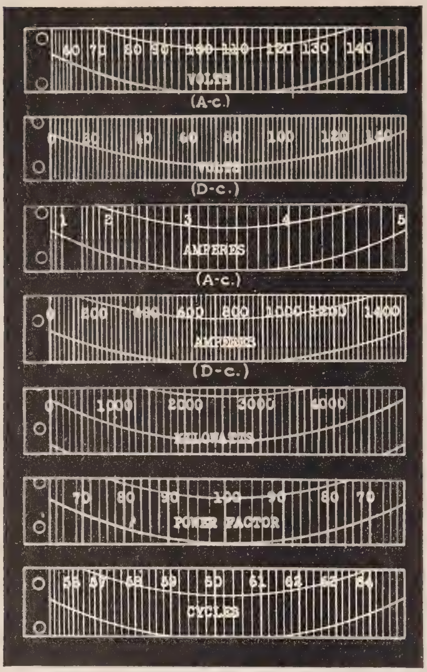


Fig. 19—Types of charts used on electrical meters.

meters for use on alternating current or direct current. It will be noted that the divisions are approximately uniform. In the case of direct current instruments, the scale will be exactly uniform and in the case of watt meters, if properly designed, the scale will be very nearly uniform. An exactly uniform scale is a great advantage, but is very hard to obtain. The relay type of graphic meter having the gravity type of control is the only one besides the direct current instrument which necessarily have an exactly uniform scale.

Fig. 20 shows two types of graphic meters and three types of clocks. The small device at the front of the picture is a synchronous motor used for driving a number of different types of meters. The meter on the right is a demand meter in which the watt-hour meter element drives the pen up scale for a pre-determined interval and then resets. This meter has not been described because it does not give any information with regard to the instantaneous values. The meter on the left is an obsolete type of relay graphic meter, but a large number of these meters are still in use, giving wonderful service.

Fig. 21 shows that manufacturers are awakening to the fact that it is quite necessary to be able to remove the ink well and pen from a graphic meter for filling and cleaning. The

Fig. 20—Two types of meters and three types of clocks.

Fig. 21—Ink well and pen removed from meter for cleaning and filling.

Fig. 23—Pen and ink reservoir of a more recent type of graphic meter.

writer has seen some sorry looking meters because the pen and ink well could not be easily removed, because the ink well does happen to run over some time.

Fig. 22 shows the ideal method of taking out a pen, that is, simply lifting it out. Just recently the writer had to take a pen out of an old type meter and it required a couple of hours because the ink had so corroded the threads of the screws holding the pen that they could hardly be removed.

Fig. 23 shows the pen and ink reservoir of a more recent correct acting Graphic Meter. The manufacturer has not gone quite far enough and it is still necessary to remove two screws to get the ink well out and to loosen one to remove the pen.

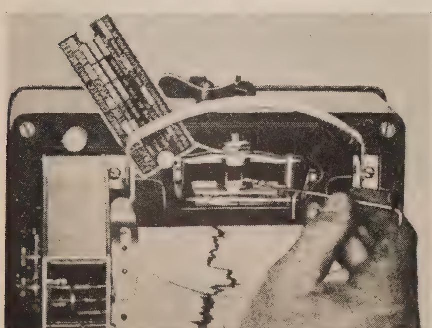


Fig. 22—Method of taking pen out of meter.

Classification of Meters

From the illustrations it can be seen that meters of the graphic type are quite varied as to purpose and principle. The field has been by no means covered and a brief summary which will include a reference to other types of meters than those shown will now be given.

Mechanical Meters

There are a great many types of mechanical meters, such as water level recorders, pressure recorders, temperature recorders and steam flow meters. Most of the above have round type charts and are generally cheaper than these having strip type charts.

Electrical Meters

Meters which measure electrical quantities are made in various forms to measure any of the electrical quantities. The watt meter is probably the one most used, and in many cases is a very important meter. When used in a permanent location to record large power loads for the purposes of billing, under these circumstances the cost of maintenance, permanency of caliberation, continuity of records and ease of making repairs are all very important.

There are also ammeters, volt meters, power factor meters, reactive component meters and frequency meters. All of these have their particular uses, but in the alternating current meters it is only the watt meter that has a uniform scale.

The Example

Assume that it is required to obtain a two weeks' record of the operation of a department of a factory having three motors, 100 horse-power, 25 horse-power and 10 horse-power respectively, and a baking oven controlled by a thermostat which takes a load of 60 kilowatts. The latter is supposed to run only at night when the other loads are off.

The total load will be 225 horsepower, which corresponds to approximately 200 amperes at 550 volts. Graphic meters are made for use directly on 550 volts without potential transformers. A pair of current transformers having a ratio of 200 to 5 amperes would probably be the most suitable. If the graphic meter has a usual rating of 5 amperes, 550 volts, the full scale of the meter will be 200 kilowatts.

The watt meter will be the most suitable because it has a uniform scale, and even the 10 horse-power motor, if run alone, would give an indication of 4 per cent. of full scale at full load. The current transformers should not be of the clamp-on variety, because no current transformer would operate satisfactorily on 200 volt amperes.

There are three types of meters to be chosen from, the direct acting, the relay type and the thermal-demand type, if it is decided to use a watt meter. If information desired is only the average load on the plant, and the information as to duration of shut downs is not important, the thermal-demand type would probably give the required information. If the load is badly variable the thermal-demand meter should be used.

If the load is reasonably variable and it is possible to mount the meter in a permanent location, so that a pendulum clock could operate, the relay type of graphic meter will give an extremely good chart on paper having rectangular co-ordinates and should not require any attention for a complete period of two weeks.

The direct acting meter having good damping could be used even though the load was quite variable. The ink reservoir would probably have to be filled before the two weeks had elapsed, and the pen would have to be thoroughly cleaned out before the meter was started up if it would continue to ink properly throughout the whole period. If a record is desired of rapidly changing quantities and it is desired to use a high paper speed, the direct acting meter should be used.

A zero test should be taken on the meter before the motors are started and also when the run is complete. In the case of permanent meters and large billing loads, the zero test should be taken every day.

Connection diagrams are supplied with all meters and, of course, must be carefully followed if the record is to be of any value. The details mentioned previously about stamping the chart with the date, location, load, current transformer ratio, potential transformer ratio and full

scale will have to be taken care of by the attendant. It will be desirable to cut a roll into twenty-four hour lengths and stamp each chart. It is quite evident that a great deal of the value of the charts are lost when they are left rolled up. It is then not possible to compare one day's chart with another, and unless special filing cases are provided, the charts are thrown into a corner of a drawer of a desk, whereas if they were cut into twenty-four hour lengths and folded properly they could be included in the regular filing cabinet with the report on the operating conditions at the time of the test.

The above will indicate the calculations necessary and the desirability of analyzing the requirements before the test is started. After the test has been completed, the chart should be carefully studied, considering power consumption, delays, operation of the thermostatic control of the electric furnace, whether the electric furnace is being operated during the heavy load period, differences between the operation record on different days, and also to discover the reason for all the peculiar characteristics shown on the chart. There is no real reason why as much information could not be obtained from the above assumed record as is obtained from an engine indicator diagram.

The records should be kept and compared with later records of the same department.

Not Fair

By J. Edw. Tufft

Bill Silken's barn is well equipped with every known device, so he can handle all his work in clever way and nice, so he can feed his kine and swine in just a little trice. The water's piped into the stalls where thirsty cows may sip, the little calves have airy stalls where they can butt and skip, the little colts have pleasant pews where they can kick and trip.

So much for that, but, ah—the house ! There is no comfort there. Bill's wife must rest her sagging bones on crudest kind of chair, must cook her meals as best she can with ancient kitchenware. Bill's wife must use an aged tub and washboard, too, alack, must scrub until her muscles ache and all her tendons crack, must toil until a steady pain has centered in her back.

It may be fair thus to equip a stable for a cow, and fit it out in modern way from weather-vane to prow and then neglect the gentle wife,—it may be fair, some how ; but I was raised to think a wife much better than a horse, and even better than a pig or choicest sheep, perforce, and it is hard to change my mind now that I'm old, of course.

—*Ontario Farmer.*

Precautions Against Freezing of Fire Extinguishing Appliances

(*Excerpted from Bulletin No. E-9 of National Fire Protection Association.*)

UNLESS extreme vigilance is exercised the very best installation of fire appliances may suffer temporary disablement from frost. Automatic sprinkler systems, hydrants and all appliances using water for fire extinguishment naturally require special care and attention in winter. The following precautions should be taken, inspections being thorough, with nothing taken for granted :

Sprinkler Equipment

Be sure that engineer or supervising employee is fully posted as to the purpose and intention of every valve and pipe. It is also essential that the night watchman should understand the operation of all valves and the importance of giving proper and prompt alarm.

Buildings.

See that all portions of buildings are properly heated at all times to prevent freezing in any of the sprinkler pipes, particular attention being given to exposed places such as hallways, entries, stair towers, elevator shafts, show windows, shipping rooms, attics, roof monitors and skylights, and spaces between ground and first floor and under sidewalks.

Entire systems have been rendered inoperative through neglect of such locations. To be safe from freezing a temperature of at least 40 degrees Fahrenheit should be maintained.

Tanks and Fittings.

Examine tanks and all pipes, fittings and valves, whether for steam heating, general water service, or fire protection. See that none is frozen or has been frozen, and that they are all in operative condition ; and where there is any liability of freezing, provide the necessary protection.

Besides seeing that tank heaters are in proper order it is important to make certain that they are of adequate capacity for the tanks they serve. Both heaters and circulating pipes should be cleaned of any rust or sediment.

Tanks should be cleaned and tank supports properly painted.

Examine carefully and provide suitable boxing around any pipe lines which may be in exposed locations (either between ground and first floor, between buildings, or near windows, etc.). Make frequent tests during the winter in order to make sure the piping is free from frost.

Open joints or gaps in the boxing are a prolific source of trouble. It is essential that all such defects be discovered and remedied forthwith. Joist channels and tank platforms are places of special danger in this respect.

First Aid Apparatus

Water Barrels, Pails and Hand Pump Extinguishers

Where water barrels, pails, or hand pump extinguishers are located in

rooms subject to freezing temperatures, use calcium chloride to lower the freezing point of their contents. The following table shows approximately the temperatures at which water will freeze when calcium chloride (commercial 75%) is added in the proportions shown to depress the freezing point :

Approximate Freezing Temperature Degrees Fahrenheit.	To Make 2½ Gallons Anti-Freezing Solution: Water	Calcium Chloride	Specific Gravity	Degrees Baume
10°	2 Gals. 1 qt.	5 lbs.	1.139	17.7
Zero	2 Gals. 1 pt.	6¼ lbs.	1.175	21.6
10° below	2 Gallons	7 lbs. 6 oz.	1.205	24.7
20° "	2 Gallons	8 lbs. 6 oz.	1.228	26.9
30° "	2 Gallons	9 lbs. 2 oz.	1.246	28.6
40° "	2 Gallons	10 lbs.	1.263	30.2

The strength of the solution obtained may be tested by using a hydrometer to determine the specific gravity. This is necessary in the case of a solution which has been standing a long time, or which has been made from calcium chloride not freshly opened.

Close fitting covers on calcium chloride solution containers will help to preserve the solution as mixed. The inside of all containers to be used for calcium chloride solution should be coated with asphaltum paint.

Calcium chloride is recommended in place of common salt because the latter will always rust metals and may become objectionable because of its tendency to "creep" and crystallize all over the receptacle. In an emergency, common salt (not rock salt) may be used when the solution is kept in wooden casks and where temperatures lower than Zero Fahrenheit will not be encountered. Two and three-quarters pounds of salt to each gallon of water should be used, producing a solution having a specific gravity of 1.205. Salt solution must never be kept in metal containers.

Chemical Extinguishers (Soda-Acid and Foam Types)

Anti-Freeze Extinguishers normally employing solutions which will withstand temperatures as low as 40° below zero require no special attention in cold weather. When extinguishers are not of the anti-freeze type (*i.e.*, are either of the soda acid or foam type) the following cautions should be observed :

See that no extinguishers of these types are exposed to temperatures lower than 40 degrees Fahrenheit. Diluted sulphuric acid may freeze at a higher temperature than water ; and at from 36 to 38 degrees Fahrenheit there is likely to be material precipitation in the soda solution. Low temperatures may also produce a noticeable retardation of action even though precipitation is not evident. The freezing point of the soda solution is practically that of pure water.

Absolutely prohibit the addition of "non-freezing" compounds *of any*

character to the contents of these extinguishers. Extinguishers have frequently been rendered inoperative by this means, and fatalities are on record, due to bursting of extinguishers as a result of corrosion induced by such treatment. The addition of salt or calcium chloride to the soda solution causes chemical changes which defeat the essential principle of operation of these appliances.

Frostproof cabinets for chemical extinguishers, even when they contain some heating unit, should be provided only in consultation with the Inspection Department having jurisdiction. Expert opinion is necessary in each case as to the conditions under which such cabinets may safely be used.

General Precautions

Instruct the night watchman thoroughly in the use of all fire apparatus, the operation of all valves, and the proper method of giving an alarm. Employ only able-bodied and intelligent men of good character in this important position.

Place thermometers in the colder portions of the plant and keep close watch upon temperatures during severe weather.

Have all broken windows and skylights repaired and all outside doors made thoroughly weathertight. See that no attic ventilators are left open to the outer air.

Secure maximum efficiency from available heating equipment by having all boilers and flues cleaned before winter arrives.

To thaw water pipes that have become frozen, wrap the frozen section with cotton cloth and pour hot water upon it until the ice in the pipe gives way. Rags on the floor at the base of or under the pipe will absorb the waste water. If the freezing is too severe to yield to this treatment send for a plumber.

Good results have also been secured by use of electricity where proper apparatus was available.

A burning match, torch or open flame of any description should never be employed to thaw pipes. To wrap the pipes with oil-soaked rags and set them on fire is worse than folly ; it is incendiarism. Pipes are almost invariably adjacent to walls or partitions where there is an ascending current of air to feed and spread a flame. Even if the flame does not start a fire its sudden local heat may cause the pipe to break and flood the premises with water.

Make sure that yards around buildings are kept clean and in good order. Obstructions such as lumber and miscellaneous storage, at all times undesirable, may interfere very seriously with the handling of hose streams in a fire occurring after a heavy snowfall, particularly at night.

At all times consult and co-operate to the utmost with the inspection department having jurisdiction. Also do not fail to call upon your local fire department for advice and help.

The Old Order Gives Place to New

"THE old order changes, giving place to new." Hydro-electric power has made another step forward in Ontario.

Henry Bowmann, farmer, of Waterloo County, has signed a twenty-year contract with the Hydro-Electric Power Commission of Ontario. This contract is in the head office on University Avenue now.

And there is more in that than meets the eye. For Henry Bowmann is a Mennonite of the old school, a follower in the footsteps of the Mennonite men and women who brought their simple faith with them to Canada nearly a hundred and fifty years ago.

Henry Bowmann who farms the land his forefathers farmed, three miles from Conestoga, is a man of influence among his neighbors of the "Old" Mennonite faith. And Henry Bowmann will be the first "Old" Mennonite farmer in Waterloo County to use electricity. In less than a week the wiring will be done and the power will be turned on in Henry Bowmann's big house and bigger barns. And a new order will be ushered in.

There are still many, and those not the poorest, among the descendants of the first settlers of Waterloo County who adhere strictly to the faith of their fathers, and the discipline of the "Old" Mennonite Church.

In the old days and old lands the Mennonite rule of simplicity and peace brought terrible persecutions upon unbelieving people. In a new land and later days the same rule has kept its followers safe from "modern improvements," free of the "curse of the telephone" and untouched by the "blight of the automobile." Automobiles and telephones are among the things for bidden to members of the "Old" Mennonite Church.

All these years electricity has been forbidden too, and the "Old" Mennonite people have kept right on going to bed by candlelight in Waterloo County "the cradle of Hydro."

Waterloo County saw the beginning of the Hydro-Electric movement nineteen years ago. On Oct. 12, 1910, Adam Beck touched the button that lighted the streets of Kitchener with electricity. It made no difference to the "Old" Mennonites.

Since then Hydro-Electric lines have carried power to the farmers in every part of the county. But not to the farm of an "Old" Mennonite.

These people, obedient to the rules of their Church, turned their eyes from the power lines that ran past their doors, and their thoughts from such things as electric separators and feed-crushers, electric stoves and irons. The faithful still took down the old barn lanterns and went out to do the chores, still lighted their big brick houses with the lamps and candles of an earlier day.

Still do in fact. But not for long now. The ban was lifted this year. The Bishop who leads the "Old" Mennonite churches decided at a conference in Pennsylvania this summer that the use of electricity in business was lawful for his people.

And next week the power will be turned on in the house and barn of Henry Bowmann three miles from Conestoga.

Credit for the latest step in the march of progress in North Waterloo goes to Earl Koch, head service man of the Kitchener Rural Hydro Service. Good authorities declare that Earl Koch "never left Henry Bowmann's farm for two days, and never stopped talking Dutch to him all that time."

Interviewed by *The Clobe*, Mr. Koch modestly rejected his laurels.

"The 'Old' Mennonites, they like to have things convenient just the same, as anybody else," he said. "They're just kind of slow to make up their minds. I talked to Henry Bowmann and told him how nice it would be—that's all. It's part of my job, you see.

"He decided to have it when he'd thought it over. And he's putting it in right, too, in his own house and his father-in-law's and the barns. They'll be able to do everything by electricity now if they want.

"Automobiles next ? No, I should say not. If they did they'd have to leave the Church. No telephone either. Not the 'Old' Mennonites up here."

There is some comfort in that.

— *The Globe.*

Association of Municipal Electrical Utilities

Primary Ballot

The Report of the scrutineers giving the results of the primary ballot for nominations of candidates for office for 1930 shows the following results:

President,—R. L. Dobbin,
A. W. J. Stewart.

Vice-President,—J. W. Peart,
H. F. Shearer.

Secretary,—S. R. A. Clement,
B. Faichney.

Treasurer,—D. J. McAuley,
G. J. Mickler.

Directors, from the Membership at large,—O. H. Scott, R. H. Starr, J. E. B. Phelps, J. R. McLinden, W. E. Reesor, O. M. Perry.

District Directors,—

Niagara District—J. E. Teckoe, J. G. Archibald.

Georgian Bay District—H. Campbell, J. C. Miller, Ross Martyn, J. A. Hare.

Central District—C. T. Barnes, G. E. Chase.

Eastern District—J. R. Smith.

Northern District—T. W. Brackinreid, Geo. Caldwell.

The above names, subject to the wishes of the nominees, will appear on the election ballots which will be distributed and returned on the first afternoon of the Winter Convention at the Royal York Hotel, Toronto, on January 29 and 30, 1930.

Hydro News Items

Central Ontario System

The municipality of Cobourg has completed arrangements to vote on the necessary by-laws, on December 9th, authorizing the purchase of the water, gas and electric utilities.

* * * *

Owing to the rapid increase in load at Trenton, it is necessary to increase the substation capacity. A new substation will be erected in a more suitable location with regard to the load and steps are being taken to carry out this work immediately.

* * * *

Georgian Bay System

Work was recently completed on an extension to the Simcoe Elevator in Midland, bringing the capacity up to 4,000,000 bushels. This elevator is served from a separate 22,000-volt substation owned by Midland.

* * * *

A rural extension comprising approximately fourteen miles of line was completed on October 16th in Port Perry Rural Power District and serves Blackstock, Nestleton, Caesarea and the adjacent summer area. Initial service has been given to 85 consumers and it is expected that a large number of additional consumers will be taken on next summer.

* * * *

Niagara System

The Preston Light and Water Commission propose to purchase one 1,500 kv-a., O.I.S.C., 3-phase transformer to be installed at present in their existing substation, along with the three 750 kv-a., 3-phase, W.C. transformers. It is expected that increased load will eventually make the erection of a second substation advisable and the new transformer is being purchased for outdoor use.

* * * *

Oxford County contains many homes where the Hydro servant has been summoned, and is one of the leaders in the use of Hydro on the farms. All up and down the highways and concessions, neighbors are talking and planning Hydro and more Hydro.

Woodstock Rural Power District, one of the four rural power districts in this county, was formed in 1922 and commenced operation in 1923. By the end of 1923 there was a total of 225 consumers, making a system demand of 96 h.p. A recent survey of the district shows a total of 565 consumers, approximately 300 of which are farm services, and a system demand of 397 h.p. The following equipment was found to be in use in addition. to the lighting :

128 motors ranging from ¼ to 10 h.p.

75 electric ranges.

66 hot plates of various sizes.
104 washing machines.
32 electric radios.
172 toasters.
Numerous small miscellaneous appliances.
Practically every service had an electric iron.

The progress of the other rural districts in this county compares favourably with the above, a condition that aids materially in making it one of the banner counties in the province of Ontario.

Public Lighting of Fintona

Fintona, County Tyrone, Ireland, is not in the list of towns with all-electric public lighting. It is not in the corresponding gas list, even oil lamps are unknown. The result is that when a wake, christening or wedding takes place in Fintona, terrible things occur. The *Northern Whig* refers to the position thus :—

At a wedding in the town recently, pandemonium reigned, and the usual bonfires were lighted. Two pigs were so frightened at seeing the light, to which they were not accustomed, that they made their way out of the town, and were found two miles away next day.

The inhabitants will not agree to levy a special rate for public lighting. It seems that each penny in the pound only brings in a total of £7.

The Electrical Times.

Window Display, Hamilton Hydro Shop.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

THE BULLETIN

Published by
HYDRO-ELECTRIC POWER COMMISSION
of Ontario

190 University Avenue
Toronto

Subscription Price $2.00
Per Year

Dona Naturae pro Populo Sunt

By A. E. Davison, Transmission Engineer, H.E.P.C of Ont.

PUBLIC ownership, as exemplified by the Hydro-Electric Power Commission, is comparatively young and not yet has tradition become an important factor in the lives of those closely associated with this organization. "Hydro", however, has reached its majority and is already in a fair way, like most institutions of importance, to outlive the economic life of the individual ; it is therefore to be expected that traditions and past records will, in the future, be much more appreciated and respected than they are now, by those who have been in close touch with the work of the Commission since the early days.

In the minds of the older members of the staff there is a rich store of "Hydro" lore connected with incidents in the life of the late Sir Adam Beck. Many of these might well be put on record and it is to be hoped that someone will write a biography of that worthy Knight, recounting some of his experiences during the earlier development stages of the "Hydro" movement. One feature of the progress of "Hydro" through the years which may be of some interest, is the entrances to some of the buildings used by the Commission and it is with these that the present article will deal.

Entrance to National Life Chambers, where the Hydro-Electric Power Commission first met.

CONTENTS

Vol. XVI **No. 12**

December, 1929

	Page
Dona Naturae Pro Populo Sunt	409
Application of Hydro-Electric Power to Farm Work	415
Modern Trends in Station Design	423
A.M.E.U. Notes	434
Hydro News Items	436
Index to Vol. XVI	438

The thirteen 110,000-volt substation buildings from which the Commission first distributed power have now grown to several hundred, including large generating stations, office buildings, warehouses, rural substations, etc. The entrances to some of these buildings are of more than casual interest to the staff and others who have passed and repassed these portals hundreds of times in the service of the Commission and of the people of Ontario.

The present Hydro-Electric Power Commission of Ontario which was organized in 1906, first met in the National Life Chambers, 25 Toronto Street, Toronto. The Ontario Power Commission and the first Hydro-Electric Power Commission of Ontario, which were succeeded by the present Commission also occupied this building for some time, the entrance to which compares favorably with more recent efforts.

From about 1907 to 1915, the Hydro offices were in the Continental Life Building at the corner of Bay and Richmond Streets. Occupying the seventh floor only for some time, it was not long after the first delivery of

Doorway of Continental Life Building, second home of the Commission.

power from Niagara Falls in 1910, that additional space was obtained on several other floors as the Commission found it necessary to increase its staff.

In 1915-16, the present Head Office, the Commission's Administration Building, was built on University Avenue. Additional Head Office space has had to be provided from time to time by securing a number of buildings on Murray and Orde Streets immediately to the west and north of the Main Building, and also on Elm Street and Dundas Street nearby.

A photograph of the entrance to the Administration Building is reproduced, carrying a coat-of-arms modelled after that of the Province of Ontario and bearing an inscription,

Entrance to the Administration Building of the Hydro-Electric Power Commission of Ontario.

consistent with public ownership ideas, which translated is as follows :—"The Gifts of Nature are for the People."

Entrances to other buildings, which show considerable talent on the part of the designers, and which are familiar not only to those who have had dealings with the Commission but also to thousands of the general public, are also illustrated.

The west (main) entrance of the gate-house at Queenston, which was finished during the War, typifies a style of architecture similar to that found in the Head Office building. This entrance is used by almost every visitor to Niagara Falls who is

interested in large power developments.

The first purchase of a large power plant by the Commission was that of the properties of the Ontario Power Company at Niagara Falls. This was in 1917. The doorway from Queen Victoria Niagara Falls Park is

West Entrance of the Gate-house at Queenston Power House.

Doorway of the O.P. Plant at Niagara Falls.

of different design from those already referred to. As will be seen from the photograph, it is imposing and attractive; of all the entrances to publicly owned buildings in Ontario, it is probably the one best known to travellers from all over the world.

Another well-known entrance is that to the power-house built by the Electrical Development Company whose properties were purchased by the Commission in 1920. This is another treatment of the Doric columns and other Greek architectural effects found in the Head Office building.

There is no doubt that as time goes on tradition and sentiment, growing around these various buildings, will be consistently cumulative, for within these dignified entrances none seek to exploit the "gifts of nature" for his own benefit, neither does he try to control the labour of others merely so that he himself may later live in greater comfort. Tradition will establish and confirm within these walls the practical application of the motto—"Dona Naturae pro Populo Sunt".

Credit Where Credit is Due

Reeve J. A. Morrison, Apple Hill, in a friendly and kindly letter to the Editor, makes some observations on coming municipal elections. Incidentally, Mr. Morrison makes mention of the Hydro System and pays the following tribute to the splendid service being rendered in this district. He says "We had a fine example of

Entrance of E.D. Plant at Niagara Falls.

service this evening. Unfortunately our Hydro failed. We communicated with our local Superintendent about 5.30, and was surprised at 7 p.m. to have light as usual. When one considers the distance these men travelled on Saturday evening, after a week's work, and willingly repaired the line, it surely means a great deal for the users of Hydro to have men who are not shirkers. How easily they could have said, "we will see to it to-morrow, and have enjoyed the evening at home, while we prowled around with lanterns. We applaud a hero, but forget men who every day are doing their best to brighten the lives and duties of their fellow men."

—*The Winchester Press.*

It should be noted that on the occasion referred to the local Superintendent had to go from Winchester to Apple Hill, a distance of about 30 miles.

Application of Hydro-Electric Power to to Farm Work

Article No. 19

An Interesting Installation on a Simcoe County Farm

A YEAR ago last June a station was installed on the Georgian Bay System L.T. line that serves the south end of Simcoe County at Fennell's Corners, between Bradford and Barrie to serve farmers in Innisfil Township, residents in the hamlets of Gilford, Lefroy, Churchill, Bell Ewart and the summer cottagers along the lake shore in the De Grassi Point and Big Cedar Point sections. At this time a Class 3 service was connected to the Elmer Rothwell farm, the birthplace and old home of one of the Commissioner's well-known engineers, Mr. H. D. Rothwell, under whose supervision the installation was made with a view to having a maximum of utility with a minimum of frills.

In wiring, an underground service was run from the transformer on the road to the service entrance and meter box shown in Fig. 2, thence underground to the centre of distribution in the house and to the barn, using lead-covered rubber-insulated cable laid in a plowed trench. The inside wiring installation in all buildings was made with non-metallic cable and fittings.

As far as possible the "last word" in equipment and appliances were installed including a thermal overload relay with no voltage release and push button control for the 3 h.p. motor, a thermal control on the furnace blower, a dual arrangement of the water system to provide hard and soft water supplies using one pump (automatic on each service, one at a time), this small unit supplying all the water needs on the farm both in the house and barns, the quarter-horsepower motor, portable so as to make the most use of it, the three-horsepower motor and chopper so set up that attendance is not necessary

Fig. 1.—General view of farm buildings with an underground service. No poles in the lane and no maintenance of lines for a long time.

Fig. 2.—Service box and meter on a pole in the yard with the transformer pole in the distance on the road, making a convenience of control in case of necessity and for reading meters whether the family is at home or not.

Fig. 3.—A corner of the living room, suggesting comfort in the evenings for the family.

Fig. 4.—Wash room off the kitchen. It is interesting to note that the basin in this case was formerly one of those in the old Queen's Hotel, Toronto.

except to start and stop the motor, the bin above and the chop box below making this almost an automatic process, switches and convenience plugs all over the house to provide maximum of use of appliances and electrical equipment (the figures shown illustrate this feature).

The regular family consists of four persons, occasional extra help is used and, of course, there are visitors.

The farm is approximately 240 acres and the stock usually consists of 20 head of cattle, 20 to 60 hogs, 7 horses and a goodly flock of chickens and fowl.

Threshing and silo filling are not at present included in the work for Hydro-electric power, being taken care of by one of the custom rigs that serves this district.

Table 1 gives the installation in some detail. The range now being installed is a replacement of the present kitchen stove which has served the family for about 30 years

TABLE No. 1

THE INSTALLATION

	Watts.
Lighting :	
In the house, 29 lights	1,135
In the barn and other buildings, 18 lights	525
In the yard, 2 lights	160
Electrical appliances and equipment :	
In the house :	
Electric iron	600
Washing machine	220
Dual automatic water system	200
Blower on furnace	50
Battery charger	100
Range now being installed with coal attachment	7,700
In the barn :	
3 h.p. motor belted to 6½ in. chopper	2,250
¼ h.p. portable motor for root pulper and fanning mill	220
Total of Installation without Range	5,460
Total of Installation with Range	13,160

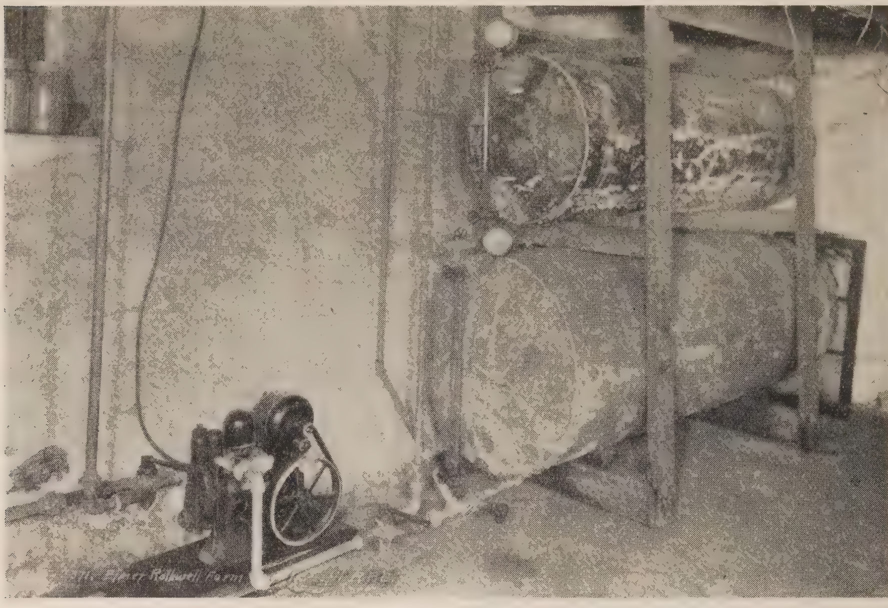


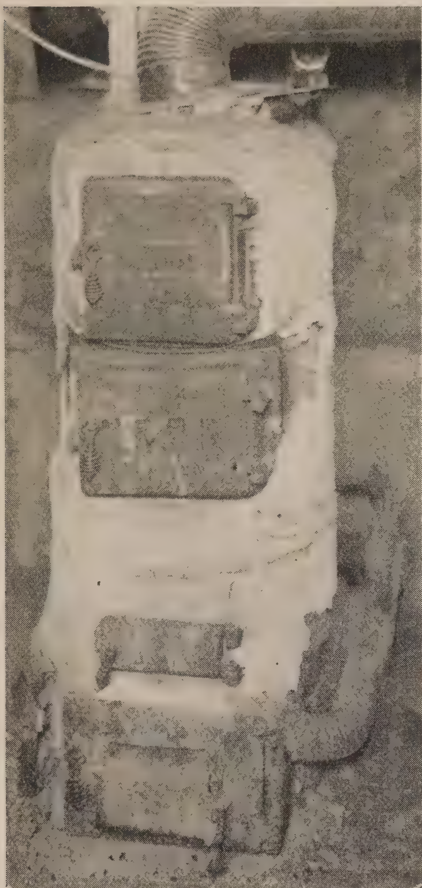
Fig. 5.—A dual water system in the basement, giving service for hard and soft water. The tank provides storage for needs during interruptions. The large one being for hard water, supplies not only the household needs but those of the barn, and is ample to take care of at least a 24-hour interruption. Both suction and discharge shown clearly provide for switching from hard to soft water and having the dual service with one pumping equipment automatic on both services one at a time.

and is not considered a part of the electrical investment for that reason. It is probable that later a load-control switch will be installed so that the men in the barn can not use the motor when the range and other loads are higher than a predetermined amount.

The cost of the electrical installation on this farm, including everything but the range (referred to above as a replacement), amounted to about $775. This cost could be increased by adding "the frills", but could not easily be decreased without sacrificing completeness and convenience.

It is interesting to note that this connected load of 13 kw. can be supplied with a Class 3 service and a 3-kw. transformer without exceeding the safe working limits of the Commission's equipment. There are many installations with as high a connected load and few complaints of fuse blowing by overloading.

Table 2 shows current consumption and costs by billing periods. The average use, you will note, is slightly less than 100 kw-hrs. per month



without the range and the average monthly bill for the year ending November 30th, $8.10. The new rates will decrease the cost of this service approximately 25 per cent.

The application of Hydro-Electric power to the services itemized results in a monetary saving, which in the opinion of the owner, would warrant even a much greater expenditure to obtain the result. The saving in the cost of chopping alone is about equal to the whole Hydro bill when one considers mill charges and time and trouble of transporting it.

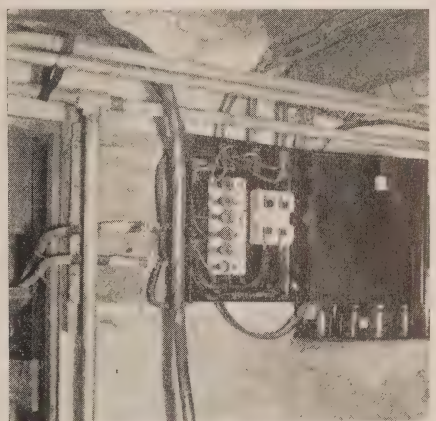
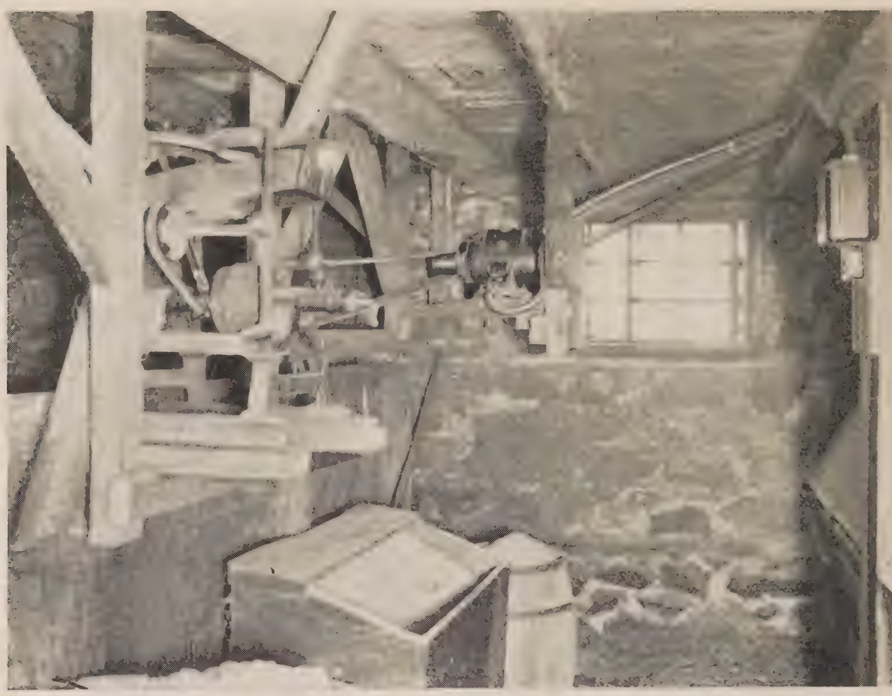


Fig. 6.—The blower on the furnace affects a great saving as the smaller sized coals may be used. The thermostat in the living room controlling this, assures uniform temperature during the whole 24 hours. Hot water heating systems in farm homes make it quite different nowadays in the early hours when one has to assume his duties before sun-up.

Fig. 7.—The distribution centre in the basement of the house, with the underground service brought through an unused cellar passage way, a cut-out is provided for stove service and non-metallic cable installed ready for this service, the stove having been ordered this month. The delay in the installation of this unit was due to a selection which would meet the approval of the women folk.



Preceding page, top—

Fig. 8.—A three-horsepower motor in the barn belted direct to a 6½ in. chopper. Non-metallic cable and automatic overload switch with push-button control, makes as complete an installation as those which are met with in factory practice. The ease of starting and stopping is much appreciated by the operators of this equipment. It is proposed at a later date to make a very complete chop box installation. That now in use is an adaptation from equipment formerly used to meet their requirements when the chopping was done at the mill.

Preceding page, bottom—

Fig. 9.—A quarter-horsepower motor in portable form, shown in this picture mounted on a plank, is very convenient on any farm, and is being used at this season for running a root pulper. This motor is also used at other times for operating the fanning mill for cleaning grain and undoubtedly for other work. It is much appreciated because the farmer dislikes manning a crank.

TABLE No. 2—USES AND COSTS,

Billing Date	Period	Total	Consumption Billed at		Net Bill	Notes
			1st Rate	2nd Rate		
June 30, 1928..		....			......	
Aug, 31, ..	2 mos.	86	84	2	$ 14.27	
Nov. 30, ..	3 "	172	126	46	22.19	
Feb. 28, 1929..	3 "	319	126	193	24.83	Illness—air heater in use.
May 31, ..	3 "	289	126	163	24.29	
Aug. 31, ..	3 "	195	126	69	22.60	3 h.p. motor installed Aug. 1
Nov. 30, ..	3 "	359	126	233	25.55	
Totals.....		1,420	714	706	$133.73	
Totals for year ending Nov. 30, 1929		1,162	504	658	$ 97.27	

Averages for same period : Consumption—97 kw-hrs. per month.
Cost—$8.10 per month.

The Rate : Service charge—$4.55 per month.
Consumption charge 8 cents per kilowatt-hour for the first 42 kw-hrs. in each month.
2 cents per kilowatt-hour for the balance.
Discount—10 per cent. for prompt payment.

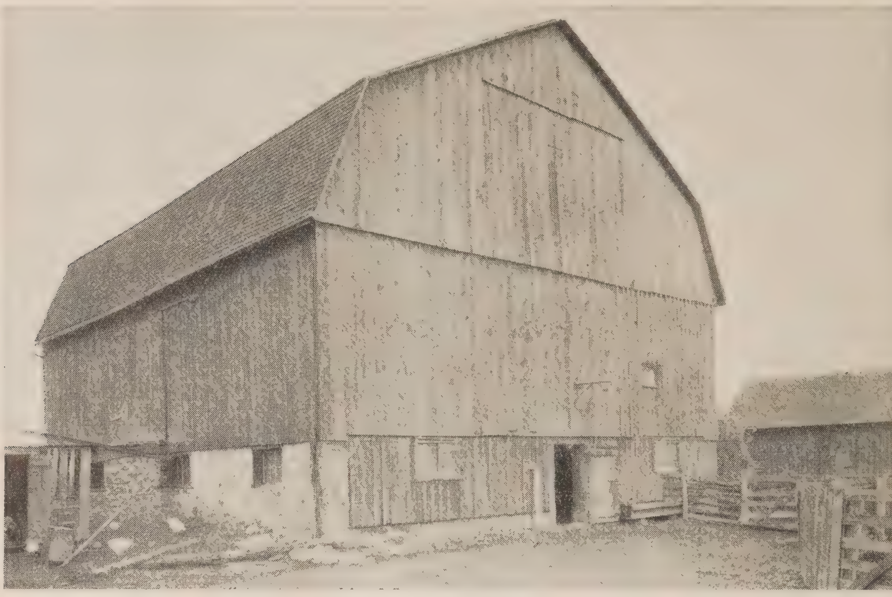


Fig. 10.—The light above the door at the barn is operated with the stable lights. Another light in the yard on a pole is operated from the house. In this way, whether at the barn or at the house, it is convenient to illuminate the yard at will. This is not only a convenience but is effective for protection from prowlers and with so much thieving in the country as at present, has a value which cannot be estimated but is appreciated by farmers in most districts today.

O.M.E.A. and A.M.E.U.

Winter Convention

at

ROYAL YORK HOTEL, TORONTO

JANUARY 29 and 30, 1930

SEE PAGE 434 FOR PROGRAM

Modern Trends in Station Design

By J. B. Kitchen, Engineer of Station Construction Toronto Hydro-Electric System

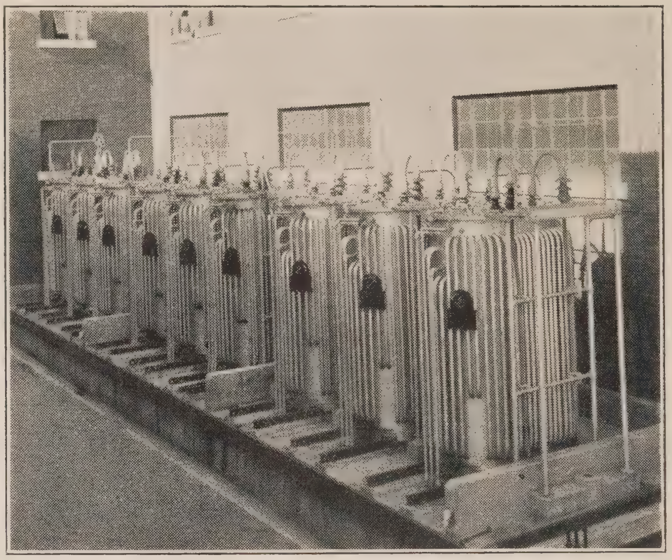
SUBSTATION apparatus and equipment changes in fashion in somewhat the same manner as wearing apparel. This change of course, has not the same significance of pride or show, but is wholly due to the constant necessity for adequate apparatus that will properly carry and control the ever increasing flow of power, permeating farther and farther into both country and city, through arteries that once showed only a trickle in comparison to present day volume.

Only a few years ago, sources of supply were small and insignificant. But today all civilized countries are dotted with gigantic Hydraulic and Steam Power Plants, capable of supplying huge quantities of power to cities, towns and rural districts, often times over distances undreamed of a few years ago. This development has not all transpired at once, but has taken place over a period of years. However, the increase in load has been so vast, that engineers have been hard pressed to keep up with the demand for a commodity that has become so popular. Again, the technical advance has been so great, from a condition of almost complete ignorance of the fundamentals of transmission and distribution to our present-day knowledge of the subject, that engineers have been equally hard pressed to keep their plants up to the minute in efficiency and economy of operation.

And even now, if we will only visualize the future carefully, it is not difficult to perceive that, in line with the multiplicity of improvements already made, the present fast development towards greater simplicity will make our present equipment appear cumbersome and out of date. In all too short a time, what we prize today as being the last word, may become obsolete all too soon. We have good reason to suspect all of this in the future, for we have experienced it in the past.

There are indications at present sufficient to enable one to make the fairly safe prediction that insulation and higher potential will be two of the leading factors in this advancement —one of course depends on the other, insulation being the predecessor to high voltage. Of late, we are being made acquainted with insulations that are so superior to those heretofore known, that engineers are venturing to commercialize voltages previously considered unsuitable for anything but transmission.

Higher voltage systems are being pushed farther and farther towards the final step-down to the user, until at present we hear of 110,000 volt insulated lead covered cable being experimented with, for City distribution, and 26,000 volts being quite commonly used, instead of 2,200 and 4,150 volts., which up to the present, have been common. This has come about through the persistent effort on the part of engineers to overcome the limitations of rubber, varnished cambric, and treated paper. The use of better insulating oils and insulations



Outdoor Transformer Bank, Parkdale Station.

with a phenol base, as well as more perfected porcelain, have made possible the manufacture of insulating materials which withstand high potentials.

Old traditions are gradually disappearing, since from experience gained in operation, they have no longer been found supported by present-day facts. As an illustration, the Toronto Hydro-Electric System might be cited as a good example of one public utility where one tradition has not been followed. Many systems formerly, and still, consider steam reserve plants necessary for service during interruptions, caused by transmission line failure. We have never had an old reliable steam plant to fall back on, in case of hydraulic failure. But nearly every other city the size of Toronto, has one, some quite elaborate, and others not so pretentious. This being so, it has been a question with us for many years, whether we should not also have an auxiliary of some kind or another. So far, we have not built one. There have been several times when continuity of service seemed to be hanging on a very slim thread. There have been failures—and a few of them unpleasantly long, but on the whole, for the past eighteen years, the outages are not outstanding in comparison. Fortunately this last year, we have been supplied with an entirely new source of power from The Gatineau system. This gives Toronto the happy advantage of having two sources to draw from. And whether a steam reserve plant will ever be built for Toronto, I am not able to say. If one is ever built, it will not likely be for the sole purpose of supply in case of transmission failure.

However, there are indications that our practice is becoming more and more in use throughout the world,

and stand-by plants are becoming less frequent. Engineers are gaining greater confidence in transmission lines to supply uninterrupted power at great distances from the supply. As an example of this: In Great Britain: — England, Scotland and Wales, are all being linked up with a carefully thought out system whereby all three countries will be supplied with power developed where it is most convenient for fuel supply, and from only sixteen super steam plants. The United States power companies are also gradually linking up with convenient sources of supply. This is also the case more or less, with the different countries in Europe.

Not only has adequate insulation made high voltage transmission possible, with little loss, but it has also increased reliability to a point where interruptions are a more or less negligible factor. Insulation has a direct co-relation to station apparatus and equipment.

Essentially the stations of a system are its safety valves, and give flexibility to a system whether it is part of a transmission line or of a low-tension network. They are primarily there for the purpose of centralizing control, and converting power satisfactorily for all commercial uses. Substations are the centres of zones from which power is radiated to the user. They are each an important link in the system, and the failure of any part may cause trouble to the degree that the apparatus fails to withstand safely, troubles in the power supply. The reliability of the protective apparatus in clearing the part in trouble before it is allowed to spread to greater proportions, is also a factor which determines the usefulness of the substation.

Our System

On a system such as ours, we are confronted with two distinct requirements in station construction. The first is that of maintaining our readiness to serve an ever-increasing load with a reasonable margin of safety. This leads to the building of new stations, and the extension of the

Cell Construction Using Hinged Doors and Locks.

present or older substations, and can be considered under two headings, the effect of increasing load density on substation design, and the effect of the consequent increased system capacity on older equipment already installed. Arising out of these, is the opportunity we have, to take advantage of advances in the art of electrical engineering, and a progressive improvement is thus effected in our station year after year.

The system first commenced operation in 1911, the first delivery of electrical energy being made on March 24, of that year. At the end of 1912, the peak load was 17,198 horse-power ; 13,858 meters were in use, and 35,176,000 kw-hr. of electrical energy were sold. The approximate corresponding figures for last year are as follows :—peak load, 259,000 horse-power ; meters in use, 168,000 ; and kw-hr. sold, 675,000,000.

This power was received at the Strachan Avenue Terminal Station, and was distributed over two 13,200 volt feeders or ring mains around the City. Substations were located at various points on these ring mains, and of the many now in existence, only West Toronto, High Level, Market and Duncan belong to the original group then built. The Waterworks pumping station at the foot of John Street was also fed, partly from Duncan Station and partly from Strachan Terminal direct. This pumping station together with the street lighting load incidentally formed an appreciable portion of the first year's load.

The demand for power rapidly increased; small transformer houses were built in industrial areas, a substation was erected on the Island, and a small station built on the site of our present Carlaw and Gerrard substation.

During the next 10 years, this expansion continued, and the 13,200 volt network rapidly grew. Many additional feeders were installed, and the first unit of the Carlaw substation was being built. Duncan substation had been extended also.

Shortly after this time, the Toronto Electric Light Company was taken over, and the two systems were amalgamated. The Toronto Hydro-Electric System, by this time, had out-grown the private company in magnitude.

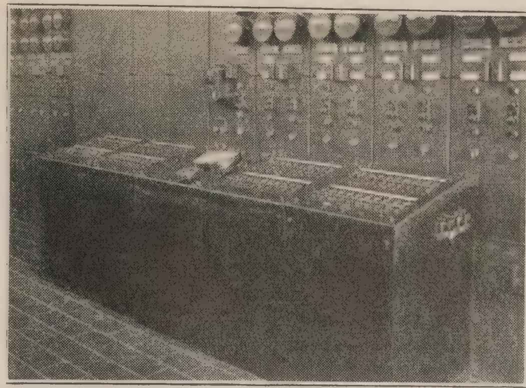
Later, the Wiltshire and Bridgeman stations were built. These supply West Toronto and High Level substations, respectively and so relieve the older Terminal station at Strachan Avenue.

It is useless to enumerate the various stations supplied by our present network, or to go into details concerning the network itself. It may be pointed out, however, that the East-end of the City is now fed from the Leaside Terminal Station of the Hydro-Electric Power Commission, at which the Leaside-Gatineau 220,000 volt transmission line terminates.

Rehabilitation

The natural growth of a distribution system to meet the demands of more consumers, and the increasing demands of old consumers, is only logical and a necessity.

Not so evident is the reason for much of the rehabilitation mentioned



Supervisory Control Board, Junction Station.

above. Why, simultaneously with growth and expansion is apparatus once installed, removed to other locations or, discarded long before it has served out its apparently useful life ?

A number of answers can be give to such questions. At times we come into possession of equipment installed by others, in a manner not up to present-day standards. Our only recourse is to remodel such installations, and so remove hazards to life, and continuity of service. This is illustrated by conditions we became heirs to on the acquiring of Terauley Substation.

In this station, all the direct current feeder cables were racked in haphazard fashion along the front wall of the station. Machine cables and 13,200 volt cables also formed part of the mass of lead and copper here seen. A fault in any one cable might quite easily wipe out of service the majority of the feeders into and out of the station, thus crippling service for many days.

Mixed in with the cables were machine circuit breakers and motor generator sets. Terauley basement was practically air-tight with little natural ventilation, and the heat resulting from cable and machine losses could hardly be imagined.

In line with a large number of other changes being made in this station, this condition received early attention.

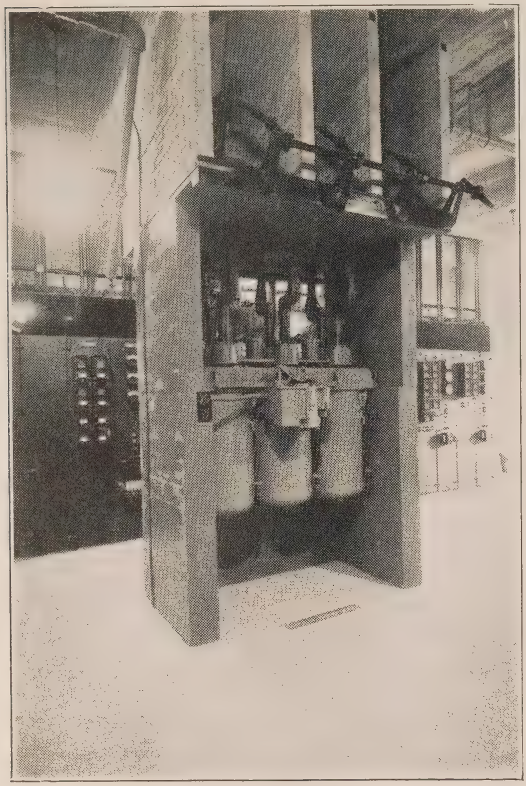
The 220/110 volt a.c. switchboard immediately above these cables also required alteration. Positive and negative polarities were hopelessly mixed together, clearances were altogether insufficient and operators had to go between live parts spaced just far enough apart for him to walk through — to operate his feeder switches, a comparatively insignificant short circuit might easily have caused destruction of the entire board.

The new board, replacing the old one, is infinitely better in every way.

On one side of a two sided structure are located all the positive busses, knife switches and feeders. On the other is located in similar fashion, the negative equipment. Clearances between parts of opposite polarity of several feet, instead of only a fraction of an inch, are now secured. The operator is not required to go between the two boards in carrying out his switching operations, and a fair number of extra circuits are available, all within about the same space as formerly. This is an example of what careful planning will do.

Obsolescence

Turning now to obsolescence resulting from system growth and advances in design the original switchboard in West Toronto Substation,



Oil Breaker and Gang Operated Disconnecting Switches.

breakers are housed in brick and concrete cells well removed from the operating board. All live equipment is carefully enclosed and protected with doors and barriers, as well as being locked, so as to prevent accidental injury to attendants or others.

Circuit breakers themselves have undergone vast changes in design. In the early days of the electrical industry, small power plants were the rule, rather than the exception, and it was seldom that any large amounts of power were concentrated on any one system. Consequently when short circuits or other troubles did occur, little energy was available for feeding into the fault, little damage was created, and troubles could be cleared by the use of relatively simple and cheap apparatus.

With the growth of distribution systems, this early apparatus became inadequate

now done away with, according to modern standards, had just about everything possible wrong with it. This is in spite of the fact that we thought it to be a perfectly good piece of construction, 17 years ago.

There was a distinct accident hazard created by the live 2,200 volt busbars at the top of the board, with the oil circuit breakers below. Operators and others could easily come into contact with live parts with possible loss of life, or at least burns and other physical injuries. In those days, men worked on this 2,200 volt bus and switch gear while alive. Nowadays the oil circuit

to withstand the duty imposed upon it, and throughout the industry, much attention has been given to this problem. A circuit breaker has two ratings, it can safely carry a continuous load of so many amperes, and it can be made to interrupt a current of some other value, usually enormously greater than its full load rating. This rupturing capacity rating as it is termed, is what determines the choice of breaker for any given job. For instance, two circuit breakers might be so designed as to safely carry a normal load of 500 amperes. But one of these might be designed to

interrupt a short-circuit current of say 20,000 amperes, while the other might likewise be designed for an interrupting capacity of very much less. Then, while both might serve very well for a small city or town, only the first would be suitable for use in a city the size of Toronto. The weaker one of the two when first called upon to act, might here show severe signs of distress through weakness of materials or poor design, spilling oil or even exploding, and so causing extensive damage to adjacent structures and equipment in the vicinity.

So in general, the bigger the system, the more rugged must be every item entering into its construction. This necessitates the discarding of old equipment which has become unsafe. And while in some cases it is possible to re-use such equipment, such opportunities are relatively unfrequent, and much of it may have to be discarded. This applies particularly to oil circuit breakers, bus and cable supports, disconnecting switches and a few other items where mechanical and dielectric strength is a consideration.

Of course, this continual rehabilitation of apparatus cannot go on for ever ; there must be an upper limit somewhere. This occurs when any system is large enough to be broken up into a number of smaller ones, and so maintain a stationary maximum for short-circuit currents. We have, we believe, nearly reached this point, and by separation of the system into several independent operating networks, can keep our troubles minimized.

The use of Gatineau power in Toronto brought up problems of its own for solution. The present line and terminal station are only the beginning of a development which will probably be about four times as large when completed. The enormous concentration of power available at that time necessitated that we take every precaution to ensure that our equipment be reliable under the worst conditions. Accordingly the breakers, and all other apparatus at our end of the Carlaw-Leaside tie-lines, were purchased with this in view.

Progress has not yet ceased. Most of our future stations will probably see the partial elimination of our brick and concrete structures. The circuit breakers then will be housed in steel cubicles which will also contain all live parts. These will be heavily insulated, and in addition to insulation, will be enclosed in compartments filled with compound completely burying them out of reach of damage.

While the above is actually on the market, and manufactured, and incidentally we have purchased a number for our West Toronto Station, there is a possibility of oil circuit breakers being again superseded by a new type of air breaker called the Deion circuit breaker, which is scientifically constructed to dissipate the arc resulting from the opening of contacts, and it is said that it will be practicable for all capacities and voltages. Of course, the real advantage of an air breaker is, that there is no oil, thereby eliminating fire hazards to that extent. Its principle and construction looks good. As to its predominating advantages over the present oil breakers, they remain to

be seen. It is supposed to be marketed next year some time.

Advances in Control

The remarkable advance in circuit breaker design has brought about equal advances in the art of their control. Formerly, when breakers were mounted on panels, little or no control conduit was required. Everything was mounted on one complete unit, breaker, ammeters, relays ; all were more or less self-contained.

However, when the breaker and its control were separated, the switchboard took on a different appearance. No longer were operating handles mounted on the panels, instead, small control switches sufficed for the operation of breakers perhaps several hundred feet distant.

This was all right in its way, but entailed the use of enormous masses of conduit buried in walls, floors, and ceilings. The thousands of feet used and the lead covered control cable required, cost large sums of money. However, if stations are to be operated by hand, the operators must have some centralized control system where everything is at his finger tips to provide quick service.

Our new stations, Danforth, Wiltshire, Parkdale, John Street, and we might also include Defoe as it is being re-vamped, mark a new departure in design. First, with Danforth we decided to dispense with station operators, and to use supervisory control, all operations being controlled over four wires from Carlaw some miles distant. Little change was made in the general design of this station from what had previously been our custom. It was felt, for instance, that supervisory control might not be all that could be desired, and that operators might prove to be a necessity, either occasionally, or as a permanent feature. So we provided a switchboard in a room by itself, and centralized all controls, meters. relays, etc., on it. Supervisory control was merely superimposed on manual control. Danforth was one of the biggest stations controlled by supervisory, anywhere, at the time it was built.

With Wiltshire, however, we had gained so much confidence in supervisory control that it was determined to take full advantage of the economies it might offer in station design. Accordingly the switchboard as such ceased to exist ; instead opposite each feeder or switch position in the structure, a panel was mounted as an integral part of the structure. The general effect was much the same as if a switchboard had been installed in one of the switching aisles, but since no switchboard room proper was required, the panels being hinged to the face of the structure, and since the panels were more or less in the centre of gravity of the equipment they controlled, material savings were effected.

In these two stations we saved about $20,000 as compared to the older method. Over two miles of conduit were eliminated, and about 12,000 cubic feet of space saved.

Supervisory control is not only applicable to the control of distant unattended substations, but can also be used in substations of large size, to advantage, under the direct supervision of operators. It is sometimes

more economical to install supervisory control than to run a mass of conduit back to an existing switchboard control gallery. This was the case at Carlaw when the new Leaside feeders were brought into the station. Here an extension had to be built to the station for the breakers and other equipment involved. The existing switchboard gallery was already filled to capacity with control boards, and yet it was desirable that the substation operator have the feeders under his direct control on the gallery, and not have to go to the breakers themselves every time one was to be opened or closed.

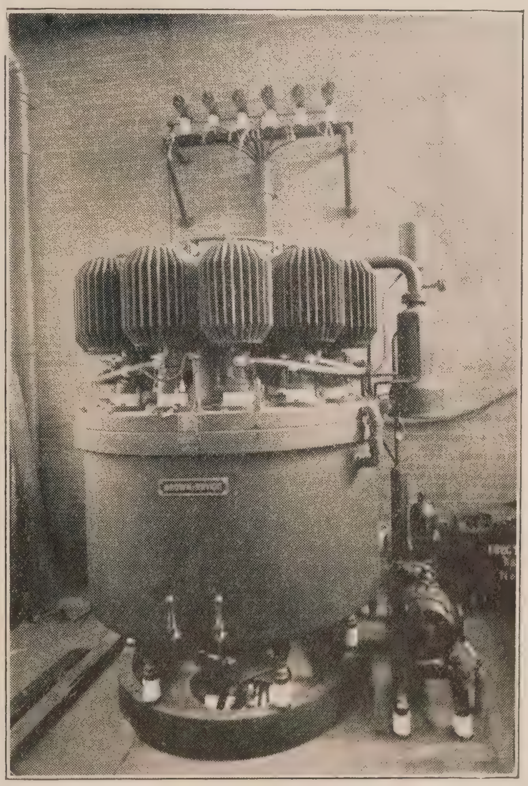
A control board was accordingly built adjacent to the circuit breakers, and on this board were mounted relays, ammeters, etc., for the proper control of the feeders. A simplified supervisory system was installed and each breaker was thus not only connected to the switchboard in the basement, but was also controlled from a small key board on the switch board gallery. By this means, all control apparatus not requiring frequent attention, was left in the new station, while the operation of the station, the opening and closing of breakers and indication of their operation was always under the control of the operator, some distance away.

Instead of about three conduits running the full length of the building for each breaker, only one was required for the total of eleven installed.

It is interesting to note that following upon this precedent, something similar is now being contemplated for a new substation being erected by the Winnipeg Hydro.

Relay Protection

In a system such as ours, various protective devices are used to open up circuits whenever trouble occurs, thus preventing widespread damage to cables or other equipment. Such devices termed relays, should only open up circuit breakers on circuits involved in the trouble, and should not cause widespread interruption to service. The design of an adequate protective system is a matter of some



1100 kv-a. Mercury Arc Rectifier.

difficulty on any system, and is particularly difficult in Toronto where so many feeders interconnect the substations. Some years ago it was seen that the old relays and circuits used for this purpose had become entirely inadequate for our changing conditions. Extensive alterations were undertaken, extending over a period of years. Many new types of relays were installed, switchboards rewired, etc., and to-day we have about as good protection as is found anywhere. On certain feeders, overload relays will operate to clear the lines ; on others, reverse power, flowing the wrong direction, will perform the same operation ; while on others, the current has to be the same in each of two or more feeders, or relays will operate to clear one of them, the faulty one.

Transformer banks are now protected so that the current flowing into and out of them must balance, due regard being paid to ratio. If not, the transformer will be cut out of service instantly.

Superimposed on all this protection is a ground relay system which serves to clear a grounded line usually before the other systems of protection have an opportunity to function. Six grounding reactors, so called, have been installed in various parts of the city. They serve to connect each of the three high tension phases in a station to ground through high reactance choke coils. If one of the phases accidentally becomes grounded outside somewhere, this reactor then permits a controlled fault current to flow ; this in turn actuates the proper relays ; and these in turn open up the line on which the fault occurred, usually before the other apparatus is affected by excessive current.

Transformers

The transformer is perhaps the most vital piece of equipment we have, for on it depends the whole theory and advantage of alternating current distribution. Receiving energy at 13,200 volts, we transform it down to several different other voltages for distribution circuits on, and under the streets. Around the transformer unit, when in large sizes, is built the substation which serves to house auxiliary equipment, circuit breakers, switchboards, and so forth ; and also provides shelter for the operator. The transformer is an excellent index as to the growth of a system.

When West Toronto substation was built, several small transformers were installed, but within two years had to be replaced by others of larger size. Not very many years after installing the transformers, the load on this station grew to such proportions that we began removing the 500 kv-a. transformers and replacing them with others just twice as big. At the present time we have six 3,000 kv-a. banks inside and two outdoors, giving us 24,000 kv-a. capacity. Plans are now under way to remove all the indoor transformers ; to place two banks of them outdoors and to replace the others with three three-phase transformers of 5,000 kv-a. capacity each. By this change we not only remove a possible fire hazard from inside the station, but we also increase the station capacity.

Our transformers have grown in size from 500 kv-a. to 1,000 kv-a.

single phase, and now in one jump to 5,000 kv-a. three-phase. Small transformers usually have fluted sides for the dissipation of waste heat; moderate sized ones frequently are made with sides of plain boiler plate, into which are welded numerous tubes which serve to increase the cooling area. In large transformers such as these, however, the surface area of the tank bears a much smaller one to the heat liberated internally than in small transformers, and consequently other measures have to be adopted. In the one shown, radiation is obtained by the use of external radiators.

For many years we have been in the habit of installing station transformers indoors, partly owing to the nature of the designs then available and, partly also, owing to a feeling of conservatism. Recently, however, transformers are being placed outdoors. They are fitted with watertight covers and outdoor insulators, and stand on simple platforms.

At Wiltshire, all connections were made on the top, a pipe structure being erected for the support of the copper work required. We improved on this construction considerably when Parkdale was built. Here we connected lead covered cable to each transformer terminal, and ran the cables down the sides of the transformers into the pit below. All connections were here made in lead covered cable. No live conductor is exposed anywhere.

Latterly we have been purchasing transformers equipped with terminals so arranged as to permit of bringing the lead covered cable directly into the transformer.

Mercury Arc Rectifiers

Perhaps no item of equipment used in our stations has undergone such a radical evolution as that of rotating machinery. Old rotary converters, for instance, were ponderous, slow moving affairs, weighing three or four times as much as up-to-date ones, and occupying a correspondingly greater floor space.

Not only has the design of rotating apparatus advanced materially in the past few years, their control too has been largely changed over to automatic devices which function more perfectly than the sometimes all too human operator. And now the rotary converter shows signs of being ousted from its former pre-eminence in the field of conversion from alternating to direct current. We are now removing the converter at Ossington, the first fully automatic machine installed in Canada, and are placing it in Danforth station where it will be the second unit of two. And we are replacing it with two 1,100 kv-a. automatic mercury arc rectifiers. These while taking up less space than the rotaries, will have more than double the capacity, and we expect will be even more reliable than the previous rotating equipment, besides being practically noiseless in operation, with no interference to telephones or radios. The mercury arc rectifier marks the latest advance in alternating current conversion, and has great possibilities especially for railway use. From all present indications it will quickly supersede rotating machinery for this purpose at least, and possibly further developments will prove its adaptability to other uses. However, at present it

has only been a successful competitor to rotating machinery on the railway systems for 500 volts and higher. This apparatus at Ossington is unique in that the whole of the primary equipment such as oil switches, arresters, transformers, etc., are installed outdoors, while the rectifiers with subsidiary apparatus are installed within the station.

—*T.H.E.C. Monthly*

Association of Municipal Electrical Utilities

ELECTION BALLOTS

The Election ballots for officers of this Association for the year 1930 will show the following as candidates,—

President—R. L. Dobbin. (Acclamation).

Vice-President—J. W. Peart, H. F. Shearer.

Secretary—S. R. A. Clement, (Acclamation).

Treasurer—R. M. Bond, D. J. McAuley.

Directors:—(From the membership at large).

E. V. Buchanan	R. S. Reynolds
W. R. Catton	O. H. Scott
J. E. B. Phelps	R. H. Starr

District Directors:—

Niagara District

A. B. Scott J. E. Teckoe

Georgian Bay District

H. Campbell*	J. R. McLinden
J. A. Hare*	J. C. Miller*

(* These received the same number of votes on the Primary Ballot).

Central District

C. T. Barnes G. E. Chase

Eastern District

J. R. Smith (Acclamation).

Northern District

T. W. Brackinreid Geo. Caldwell

The ballots will be distributed prior to the opening of the first session of the Convention on January 29, 1930. Immediately after the session has been opened they will be collected, and the scrutineers will announce the result of the election before that session closes.

* * * *

CONVENTION PAPERS

The Papers Committee has arranged for the following program for the Convention The actual titles to be given to the subjects will be shown on the Convention program, copies of which will be distributed a couple of weeks before to the Convention.

WEDNESDAY, January 29th, 1930 :

Afternoon—

Committee Reports.

Paper on Distribution Transformers and Connections, by Jos. Showalter, Canadian Westinghouse Co., Toronto.

Address "Handling of Men", by J. H. Brace, General Manager, Western Division, Bell Telephone Company of Canada.

THURSDAY, January 30, 1930 :

Morning—

Report re Research Laboratory by W. P. Dobson, Chief Testing Engineer, H.E.P.C., of Ont.

Report of Pension and Insurance Committee.

Paper on Meter Connections, by W. H. Gerrie, Meter Inspector, H.E.P.C., of Ont.

Afternoon—

Paper on Illumination, by A. F. Dickerson, Chief Engineer, Illuminating Engineering Laboratory, General Electric Company, Schenectady, N.Y.

Paper on Construction Standards, by R. E. Jones, Distribution Section, Electrical Engineering Department, H.E.P.C. of Ont.

Following Mr. Jones' paper and as part of the discussion on it, J. R. McFarlin, Electrical Engineer, Electric Service Supplies Company, will answer questions relative to lightning arresters. Delegates are asked to write Mr. H. M Fierro, Manager, Lyman Tube and Supply Company, Limited, 200 Bay Street, Toronto, outlining their problems so that Mr. McFarlin may be given an opportunity to study them and prepare his solutions.

The Committee is to be complimented for arranging a program that should prove of interest to all of the delegates. There will be something that will make attendance at the Convention worth while to everyone. Special effort should be made therefore to be present for this will no doubt be another of those very successful Conventions of the Association.

John A. Clark, Thamesford

We regret to record the death of John A. Clark of Thamesford Hydro-Electric Committee on Wednesday, November 13, 1929. Mr. Clark was a member of the Thamesford Committee for nearly fifteen years, eleven years of which he served in the capacity of Chairman. He was also completing his twenty-first year as a member of the Board of Police Trustees of Thamesford. His loss is a distinct loss to the community.

Re Municipal Populations

To enable the Bulletin to give as nearly as possible the correct populations of the Hydro Municipalities as shown in the lists on the inside of the cover, it would be of considerable assistance if the Municipal Officials advise of any corrections that should be made.—*Editor*.

HYDRO NEWS ITEMS

Central Ontario System

The Quinte Milk Products, Limited has applied for 60 h.p. for the operation of a plant in Wellington R.P.D.

* * * *

Estimates on the delivery of 1000 h.p. to the Canada Cement Co. at Lakefield have been forwarded to the company.

* * * *

Rural lines to the total of 16.75 miles are being built in Wellington R.P.D. to supply residents of the hamlets of Consecon and Rednerville and rural consumers in Ameliasburg Township.

* * * *

The municipalities of Bowmanville, Port Hope, Brighton, Napanee, Millbrook and Tweed have received all particulars in connection with the purchase of their distribution systems and are considering the submission of by-laws at the New Year elections.

* * * *

Georgian Bay System

Work instructions have been issued for an outdoor substation to be erected at Fergusonvale on the Waubaushene-Barrie line, and also for ten miles of rural line to serve the hamlets of Phelpston, Hillsdale and Craighurst. The work, however, is being postponed until next year, but will be undertaken as soon as weather conditions permit in the spring.

* * * *

A 75 kv-a., three-phase, outdoor substation was placed in service on December 11th at Midhurst in the Barrie Rural Power District. This station will serve loads of the Provincial Forestry Dept. and the C.P.R. at Midhurst, and it is expected that a line will be constructed next year from the substation through Crown Hill and tie it with the Shanty Bay line at present served from Barrie.

* * * *

The load on the Barrie substation has reached a point where additional transformer capacity is required, and three 1,000 kv-a. transformers are on order for this substation. These transformers are being built with Scott taps in order to provide for the two-phase distribution system in Barrie. Two of these transformers will be installed immediately and the third added in the near future when the Barrie distribution system is changed from two-phase to three-phase.

* * * *

The increased demands of the municipality of Tara and the Tara Rural Power District have overloaded the substation at Kilsyth, from which both loads are served. Studies were made of the situation and it was shown that the best method of taking care of the situation was by the installation of a separate substation for the municipality of Tara. A site has been purchased in Tara and arrangements made for the

installation of a 75 kv-a., three-phase transformer which will leave the present Kilsyth station for the Tara Rural Power District.

* * * *

Niagara System

The Township of North Walsingham has signed the agreement providing for rural service in the Township.

* * * *

A new plant for producing a bituminous road-surfacing material is being erected at Dundas, which will use 150 h.p.

* * * *

A manufacturer of road machinery has purchased and is refitting the old plow works at Paris. One hundred horsepower will be used initially.

* * * *

During the past month instructions were issued covering the construction of approximately 85 miles of rural lines in the Niagara District to serve 225 consumers.

* * * *

The limestone quarry plant located west of Beachville and taking electric power is to be extended to include the manufacture of agricultural limestone.

* * * *

Some 180 customers situated immediately outside the city of Guelph and who had been receiving service from the Guelph Hydro System were transferred November 1st to the Guelph Rural Power District. Work on reconstruction of the lines in the District is progressing nicely and will be completed within a few weeks.

* * * *

A plant is being installed in Point Edward for the manufacture of automobile accessories which it is expected will require 600 h.p. for its operation. The company is installing 3-200 kv-a., 2200/440 volt transformers. The village has extended its primary of No. 000 copper a distance of 2000 ft. for this service.

* * * *

The Imperial Oil Company is extending its plant adjacent to the city of Sarnia, and proposes to take approximately 200 h.p. additional, with 1000 h.p. ultimate, of electric power for the operation of pumps and other accessory equipment used in the refining of mineral oils. At present this company is taking approximately 1,800 h.p.

* * * *

A 13,200 volt wood pole line has been erected between Toronto Wiltshire station and the town of Weston. This line carries two circuits of No. 4/0 steel reinforced aluminum with ¼ inch steel ground wire. The line passes through a district which is developing rapidly and will no doubt in the near future be required to deliver power to new stations along the route.

* * * *

Ottawa System

An extension has been built east of Ottawa in Nepean R.P.D. to serve consumers in the village of Orleans and adjacent rural consumers.

* * * *

Rideau System

Rural extensions have been completed in Smith's Falls R.P.D. which serve the area including the villages

of Jasper, Easton's Corners, Portland, Elgin, and Delta, and a further extension is now being made to Chantry and Harlem.

* * * *

St. Lawrence System

The construction of the rural line in Alexandria R.P.D. to supply residents in Glen Robertson and vicinity is about completed.

* * * *

A line extension has been completed West from Brockville in Brockville R.P.D. to give service to the villages of Lyn, Mallorytown and Lansdowne and adjacent farming territory.

* * * *

The ratepayers of the village of Cardinal recently carried by a large majority the by-law to enable the municipality to enter into an agreement with this Commission for a supply of power.

* * * *

In Maxville R.P.D. a line of 27½ miles in length is under construction to supply residents of Moore Creek, St. Isidore de Prescott and Plantagenet. This line is being constructed single-phase with provision to change it to 3-phase, 8000-volt.

* * * *

The Atlas Construction Company, Montreal, who is erecting the Lower Lakes Terminal Elevator of the Department of Railways and Canals two miles east of Prescott, will take approximately 100 horsepower from Prescott R.P.D. for this work. Arrangements have also been made to supply 150 h.p. to the rock crushing plant of Messrs. Curran and Briggs, which will supply crushed stone for the construction of this elevator.

Index to Volume XVI

	PAGE
Accidents, The Prevention of..	292
A.M.E.U. Reports....56, 106, 139, 267, 301, 332, 406, 434	
Annual Report, Mr. C. A. Magrath's Letter of Submittal of the Twenty-first.....	145
Annual Report of The Hydro-Electric Power Commission for the fiscal year, 1928....	65
Application of Hydro to Rural ElectricS ervice...........	187
Application of Hydro-Electric Power to Farm Work	415
Billing Methods, Modern.	257
Billing System, Kingston......	191
Cameron Street Substation, Port Arthur...............	111
Commissioners, Relations of Local....................	269
Demonstration at National Plowing Match at Kingston.	391
Distribution at High Load Densities, Factors Governing the Design of 115-230 volt..	247
Domestic Appliance Load Factor	48
Domestic Demand, Investigation of..................	36
Dona Naturae pro Populo Sunt.	409
Double Circuit, 110 kv. line from Niagara River to St. Thomas..................	181
Early Types of Electrical Fittings.....................	19
Electric Heating, Industrial..	29

	PAGE
Electric Installation, A Pioneer	162
Electrical Development, Suggestions for	82
Electrified Farm House, The	164
Engineering Research, Some Problems in	196
Eugenia Hydro-Electric Association Meeting	186
Exterior Lighting, Toronto-Leaside Transformer Station	70
Factors Governing the Design of 115-230 volt Distribution at High Load Densities	247
Farm Work, Application of Hydro-Electric Power to	415
Fire Extinguishing Appliances, Precautions against Freezing of	402
Flood Lighting—London P. U. Comm. Building	195
Gravel Plant Operating by Hydro-Electric Power, Large	337
Hydro and Cost of Service up to the end of 1928, Progress in the Use of	308
Hydro News Items	26, 142, 178, 217, 333, 374, 407, 436
Hydro Service, What it Costs and What it Does, Rural	119
Hydro by Domestic Consumers Grows, Use of	320
Hydro-Electric Installations	22
Hydro-Electric Progress in Canada during 1928	9
Hydro-Electric Power Commission during 1928, Progress of	1
Hydro-Electric Power Commission for the fiscal year, 1928, Annual Report of the	65
Industrial Eletrcic Heating	29
Insurance and Superannuation Plan for Municipal Commission Employees	88
Insurance Plan, Pension and	294
Investigation of Domestic Demand	36
K ngston Billing System	191
Klydonograph as a Lighting Recorder, The	359
Large Gravel Plant Operating by Hydro-Electric Power	337
Lighting Hens in Winter	213
Lighting London P.U. Comm-Building, Flood	195
Lighting Toronto-Leaside Transformer Station, Exterior	70
Lightning Problems in Power Transmission and Distribution, The	221
Lightning Surge Investigations in the United States, Status of	72
Line from Niagara River to St. Thomas, Double Circuit, 110 kv	181
Load Factor, Domestic Appliance	48
Measurement and Control of Diversion of Water from the Niagara River	385
Merchandising Electric Refrigerators	282
Meters in Industry, The Use of Graphic	341,394
Modern Billing Methods	257
Modern Trends in Station Design	423
Mr. C. A. Magrath's Letter of Submittal of the Twenty-first Annual Report	145
National Safety Congress	371
New 5000 kv-a. Synchronous Condenser in Service at Oshawa	17
New Semi-outdoor Station in the Township of Scarboro	159
New Semi-outdoor Station in the Township of York	306

PAGE

New Values in Industry...... 210
Niagara Convention and Protocol...................... 5
North York Hydro........... 390
Old Mills and Water Power Drives in Ontario.......... 189
Old Order gives place to New, The...................... 405
O.M.E.A. Report............ 101
Orillia Commission Celebrates. 117
Oscillograph Recording Apparatus for Toronto - Leaside Transformer Station........ 169
Other Fellow's Job, The....... 200
Oxygen and Hydrogen in Industry.................... 364
Pension and Insurance Plan... 294
Pioneer Electric Installation, A 162
Power Stations in Border Cities District.................. 15
Precautions against Freezing of Fire Extinguishing Appliances 402
Prevention of Accidents, The.. 292
Problems in Engineering Research, Some............... 196
Progress in the Use of Hydro and Cost of Service up to the End of 1928............ 308
Progress of Hydro - Electric Power Commission during 1928..................... 1
Progress on Second 220 kv. Transmission Line from the Gatineau.................. 305
Protective Relay Installation at the Toronto-Leaside Transformer Station..........93, 126
Relation of Science to Industry, The..................... 204
Relations of Local Commissioners.................... 269
Rubber Glove Situation, The.. 324
Rural Electric Service, Application of Hydro to........ .. 187

PAGE

Rural Hydro Service, What it Costs and What it Does..... 119
Safety, Universal............. 141
Semi-outdoor Station in the Township of Scarboro, New. 159
Semi-outdoor Station in the Township of York, New..... 306
Sense of Safety, The.......... 330
Setting Poles by Dynamite at Wasaga Beach............. 183
Short Circuit Calculating Table and its Applications, The.... 349
Station Design, Modern Trends in...................... 423
Status of Lightning Surge Investigations in the United States.................... 72
Substation, Port Arthur, Cameron Street............ 111
Suggestions for Electrical Development................. 82
Synchronous Condenser in Service at Oshawa, New 5000 kv-a...................... 17
Toronto - Leaside Transformer Station, Exterior Lighting... 70
Toronto - Leaside Transformer Station, Oscillograph Recording Apparatus for the....... 169
Toronto - Leaside Transformer Station, Protective Relay Installation at the.........93, 126
Transmission Line from the Gatineau, Progress on Second 220 kv.................... 305
Tretheway Falls Development. 377
Universal Safety............. 141
Use of Graphic Meters in Industry, The.............341, 394
Use of Hydro by Domestic Consumers Grows.............. 320
Windsor, Essex and Lake Shore Railway.................. 382